

# ***Insights on Conducting Consent-Based Siting of Radioactive Waste Management Facilities: Evidence from a Nationwide Survey of US Residents***

## **Fuel Cycle Research & Development**

*Prepared for:*

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Nuclear Fuel Storage and  
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## EXECUTIVE SUMMARY

The study described in this report was undertaken to analyze empirical evidence concerning how consent, in the context of nuclear facility siting, is understood and evaluated by a cross-section of the American public. The basis for this analysis is a series of nationwide surveys on preferences of U.S. residents concerning the environment and energy sources, initiated in 2006 and conducted annually by the Center for Energy, Security & Society, a joint research collaboration of the University of Oklahoma and Sandia National Laboratories. The 2014 iteration of the Energy and Environment survey (EE14) was implemented using a web-based questionnaire, and was completed by 1,610 respondents using an Internet sample that matches the characteristics of the adult U.S. population, as estimated in the U.S. Census.

### Public Views of the Nuclear Fuel Cycle

Public views about the siting of nuclear facilities occur within a broader context of the risk and benefit perceptions associated with nuclear energy. Continuing attention to the events at the Fukushima nuclear facility, coupled with its negative implications for public support for nuclear energy, has changed the balance of these risk and benefit perceptions, and thus the context in which nuclear facility siting efforts will occur. In addition, the portion of the public most concerned about climate change have typically been those most concerned about the environment in general, and in turn, are those that have traditionally been hostile to nuclear energy. Note however that perceived risks and support for nuclear energy are subject to change over time. Consent-based siting programs will need to be sufficiently flexible to adapt to those changes.

### Evolving Public Awareness of the Nuclear Fuel Cycle

Our analysis indicates that the broader public is not well informed about the nuclear fuel cycle including energy production from nuclear reactors and current policies for the management of used nuclear fuel (UNF). For many, should the issue of siting a nuclear facility be raised, the absence of policy-specific knowledge is likely to result in reliance on very general beliefs and risk perceptions. Designing and building a robust, trustworthy basis for communication and engagement – one that is understood by the public to be as concerned about the interests of potential host communities as it is about siting a facility – will therefore be of critical importance to the success of the consent-based siting program.

### Public Understanding and Perceptions of Interim Storage

The EE14 survey finds that respondents are reluctant to continue to rely on temporary on-site storage of UNF, and that there is moderate support for developing one or more interim storage facilities (ISFs). This support for ISFs is greater among those respondents that live closest to current storage sites. However, that support is also conditional on how proximate their residence is to the proposed ISF. The survey also finds that members of the public hold a higher “willingness to pay” (WTP) value for an ISF than continued on-site storage. Furthermore, average support and WTP is greater for an enhanced ISF with re-packaging facilities and a research lab as compared to a base ISF. These influences are likely to characterize initial public responses to ISF siting issues, and should be anticipated by program officials in the early stages of consent-based siting efforts.

### Public Perspectives on the Institutional Basis for UNF Management

The EE14 survey responses suggest that the level of trust accorded a new nuclear waste authority by the public will be sensitive to how it is institutionally defined. These results suggest that if it is defined as an independent federal agency, it will not be viewed much differently than are the independent U.S. Nuclear Regulatory Commission (NRC) or the executive cabinet-level U.S. Department of Energy (DOE). If defined as a private company, it will be susceptible to a more significant perceived bias. More generally, the survey responses indicate that the government laboratories and agencies continue to be

viewed by lay citizens as reasonably credible, though with a modest propensity to downplay risks. Both industry groups and environmental non-governmental organizations (NGOs) are broadly perceived to be more prone to skew the representation of risks (though in opposite directions), while the National Academy of Sciences (NAS) is seen as least prone to depart from providing balanced information on nuclear risks. These perceptions of bias serve to filter the perceived credibility of information and policy recommendations concerning nuclear waste options received by the public.

## **Public Views on the Design of a Consent-Based Siting Process**

When a consent-based process was defined, and respondents were asked to assume that a community within 50 miles of their homes had volunteered to be considered as a site for an ISF, majorities (or near majorities) of the EE14 survey respondents took the following positions:

- The siting process should be broad and inclusive (84%);
- Those who should have veto authority in the siting process should be limited to majorities of local (66%) and statewide voters (64%), to state (55%) and federal (50%) environmental regulatory authorities, and governors (52%);
- The state and local host community should be permitted to withdraw consent up to the point at which a license to build the facility is submitted (72%), but not after the license is received and facility construction initiated.

## **Prospective Public Engagement in Siting ISFs and Preferences for Deliberative Decision-making Panels**

The EE14 survey posed a set of questions concerning respondents' expectations about their engagement in the processes for ISF facility siting and their preferences for deliberative decision-making panels used during the siting process. Roughly half of our respondents said they would likely attend informational meetings, and nearly half said they would likely communicate with elected officials or would likely express their views on the topic via social media. Relatively few – about one in five – said they would be likely to actively participate in support for or opposition of an ISF. Also, in reference to the type of deliberative panels the respondents prefer, results indicate that while respondents are more likely to support a citizen-led deliberative panel process than one led by experts, this preference does not seem to influence their opinion about the expected outcome of that process. This suggests that decisions about how to structure engagement are important—people prefer citizen-driven processes, but preferences for a deliberative process do not predispose members of the public to support the construction of an ISF even if that is the recommendation of the process.

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## ACRONYMS

BRC	Blue Ribbon Commission on America's Nuclear Future
CES&S	Center for Energy, Security and Society, University of Oklahoma
CV	Contingent Valuation
DOE	U.S. Department of Energy
EE14	2014 Energy and Environment survey conducted by CES&S
EPA	U.S. Environmental Protection Agency
GHG	Greenhouse Gas
HLW	High-Level Waste
IP Address	Internet Protocol Address
ISF	Interim Storage Facility
NAS	National Academy of Sciences
NGO	Nongovernmental Organization
NFST	Nuclear Fuel Storage and Transportation Program, DOE
NOAA	National Oceanic and Atmospheric Administration
NRC	U.S. Nuclear Regulatory Commission
OLS	Ordinary Least Squares regression
SNF	Spent Nuclear Fuel
SNL	Sandia National Laboratories
SSI	Survey Sampling, Inc.
U.S.	United States
WIPP	Waste Isolation Pilot Plant
WTP	Willingness To Pay
UNF	Used Nuclear Fuel



# **NUCLEAR FUELS STORAGE AND TRANSPORTATION PLANNING PROJECT INSIGHTS ON CONDUCTING CONSENT-BASED SITING OF RADIOACTIVE WASTE MANAGEMENT FACILITIES: EVIDENCE FROM A NATIONWIDE SURVEY OF U.S. RESIDENTS**

## **1. INTRODUCTION**

In a report titled *Strategy for the Management and Disposal of Used Nuclear Fuel and High Level Radioactive Waste* (January 2013), the U.S. Department of Energy (DOE) outlined a national strategy for how used nuclear fuel (UNF) should be managed. In line with the recommendations provided by the Blue Ribbon Commission on America's Nuclear Future (BRC, 2012), the DOE report highlights the importance of consent-based storage and disposal facility siting. Critical elements of this consent-based strategy include open and transparent communication of the benefits and risks of various UNF management options and the incremental implementation of a “flexible” UNF storage system (DOE 2013, p. 4). The study described in this report was undertaken to inform the Nuclear Fuels Storage and Transportation (NFST) Planning Project on how consent as well as risks and benefits, in the context of nuclear facility siting, are understood and evaluated by a cross-section of the American public.

### **1.1 Energy and Environment Survey Project**

The *2014 Energy and Environment Survey* (EE14) was fielded by the Center for Energy, Security and Society (CES&S), a joint research center of the University of Oklahoma and Sandia National Laboratories (SNL). The survey was designed to measure U.S. residents' perceptions, beliefs, and preferences for UNF management policies. The EE survey series, initiated in 2006, has annually measured and tracked Americans' views on nuclear energy and UNF management.<sup>1</sup> The series has focused on a range of nuclear energy issues over time, but more recently the surveys were designed to facilitate understanding of public beliefs and perceptions regarding UNF management and consent-based siting. Fielding these surveys annually has made it possible to track public views on important issues related to nuclear energy and waste management and analyze American residents' policy preferences in the context of changing national concerns (e.g., the relative concern about the economy or national security) and evolving international events (e.g., the Fukushima nuclear event). In addition to annual surveys that provide consistent measurement over time, the CES&S also tracks public opinion using real-time social media outlets. In combination, these sources provide a robust basis for evaluating Americans' attitudes and preferences concerning consent-based siting of UNF management facilities.

### **1.2 EE14 Survey Sample Characteristics**

The sample frame for the EE14 survey was purchased from Survey Sampling, Inc. (SSI), a leading provider with direct access to more than six million research respondents plus millions of others through preferred partner relationships across 54 countries. Decisions to participate were entirely voluntary and

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<sup>1</sup> Beginning in 2012, the University of Oklahoma's Office of the Vice President for Research has funded the EE survey design and data collection. The series began in 2006, and has been fielded annually.

recruitment was carefully monitored to ensure that the sample was Census balanced and therefore representative of the U.S. population.

The EE14 survey was conducted on June 27 and 28, 2014. In total, 1,610 adults (age 18 and older) completed an Internet-based questionnaire. On average, respondents took about 33 minutes to complete the survey. The characteristics of the respondents – including mean age, percentages of men and women, race and region – approximated those of the national census, as shown in Table 1.1. When analyzing the data, the respondents were weighted to match national demographic characteristics. The technical characteristics of the survey design, recruitment, data collection and weighting are described in a supplemental report entitled *Public Preferences Related to Radioactive Waste Management, Nuclear Energy, and Environment: Methodology and Response Reference Report for the 2014 Energy and Environment Survey* (hereafter referred to as the *Reference Report*).

**Table 1.1: Demographic Attributes of EE14 Survey Respondents Compared to 2013 U.S. Census Estimation**

<b>Demographic</b>	<b>% U.S. Population 18 Yrs. of Age and Above*</b>	<b>% EE14 Respondents</b>
<b>Gender</b>		
Female	51.3	54.6
Male	48.7	45.4
<b>Age</b>		
18–29	21.8	11.7
30–49	34.2	29.5
50+	44.0	58.9
<b>Ethnicity</b>		
Hispanic	15.0	15.8
non-Hispanic	85.0	84.2
<b>Race</b>		
White	79.3	81.4
Black or African American	12.6	12.0
<b>Census Region</b>		
Northeast	18.3	18.2
Midwest	21.5	21.2
South	37.4	37.7
West	22.8	22.9

\*Note: Population estimates exclude AK, HI, and DC.

The content of the survey questionnaire ranged from queries concerning general beliefs about energy and environmental issues to specific measures of knowledge, attitudes, and preferences for the management of

UNF. The following sections use these survey responses, supplemented where appropriate with data from the CES&S's studies of social media, to report on six topics:<sup>2</sup>

1. Trends in public perceptions of nuclear energy, with particular attention to the continuing implications of the March 2011 Fukushima nuclear event and beliefs about climate change;
2. Evolving public awareness of the nuclear fuel cycle;
3. Public understanding and perceptions of interim UNF storage facilities, with an emphasis on the effects of proximity to proposed ISFs and to current temporary UNF storage facilities; and the effects of nuclear accidents such as the Waste Isolation Pilot Plant (WIPP) incident on support for ISFs;
4. Views of the expected "risk biases" of key institutions that have a role in UNF management and the mean trust in the information provided by these institutions, including alternative institutional bases for a new single-purpose entity to manage UNF storage and disposal;
5. Public views of the appropriate bases for the design and implementation of a consent-based process for siting interim UNF facilities; and
6. Public expectations concerning their levels of involvement and engagement in the process of siting ISFs, including public preferences for the types of deliberative decision-making panels to be employed during the siting process.

### 1.3 A Guide to Reading this Report

The topics covered in this report will be of varying importance and interest to different readers. An overview of the primary findings is provided in the Executive Summary.

For those who are particularly interested in the material of immediate relevance to *consent-based siting program design*, we suggest beginning with Section 4 (understanding support for ISFs), Section 6 (public views on the design of a consent-based siting process), and Section 7 (prospective public engagement in the siting process).

For readers with an interest in the *broader context that has shaped U.S. residents' perspectives on nuclear energy and UNF management* we recommend a close reading of Section 2 (the energy and policy context) and Section 3 (evolving public awareness of UNF issues).

For those who are chiefly concerned with the *variations in public confidence in agencies (and other stakeholders) for management of UNF and implications for the institutional design of a new nuclear waste authority*, we recommend reading Section 6 (public perspectives on the institutional basis for UNF management).

For a presentation of the full survey question wording, and a detailed discussion of sampling and weighting methodologies used in collection of the data, see the *Reference Report*, to be published in December 2014.

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<sup>2</sup> The EE survey series differs from popular opinion polling. Polls tend to be snapshots of public opinions on subjects that more often can be categorized with yes—no, for—against responses, typically based on information that the person can recall from memory. By comparison, the EE series is designed to investigate more complex issues that (a) require much more attention and thought from respondents (as noted by the time respondents took to complete the survey), (b) involve more complex question wording, (c) may provide balanced background information, and (d) allow more subtle response variations (as shown in the sections that follow). The EE surveys yield data that can help explain which complex policy options are preferred, why these policy preferences are formed and how they evolve over time related to the six topic areas analyzed in the report.

## 2. PUBLIC VIEWS OF THE NUCLEAR FUEL CYCLE

In order to gauge how members of the American public might respond to efforts to site nuclear facilities, we must first understand the broader context that informs these responses. This context includes the public's broader beliefs about preferred energy sources, levels of concern about major social issues like the economy and the environment, and beliefs about nuclear technologies in general. Also crucial are public expectations regarding the future mix of energy sources, the expected price and availability of different energy sources, and the perceived risks and benefits associated with nuclear energy. This section outlines the evolving public perceptions of issues that shape the public debate over UNF facility siting.<sup>3</sup>

### 2.1 Trends in Public Support for Nuclear Energy

The EE series has monitored U.S. residents' perceptions about the risks and benefits associated with nuclear energy since 2006. Each year, respondents to the survey are asked the following questions:

First we want to know about your beliefs concerning some of the possible risks associated with nuclear energy use in the U.S. Please consider both the likelihood of a nuclear event occurring and its potential consequences when evaluating the risk posed by each of the following on a scale from zero to ten where zero means *no risk* and ten means *extreme risk*. [The order of the risk questions was randomized; the labels in **bold** were not included]

**[Operational accident]** An event at a U.S. nuclear power plant within the next 20 years that results in the release of large amounts of radioactivity.

**[Transportation accident]** An event during the transportation or storage of used nuclear fuel from nuclear power plants in the U.S. within the next 20 years that results in the release of large amounts of radioactivity.

**[Terrorist attack]** A terrorist attack at a U.S. nuclear power plant within the next 20 years that results in the release of large amounts of radioactivity.

**[Diversion to nuclear weapons]** The diversion of nuclear fuel from a nuclear power plant in the U.S. within the next 20 years for the purpose of building a nuclear weapon.

Now we want to know about your beliefs concerning some of the possible benefits associated with nuclear energy use in the U.S. Please evaluate the benefits associated with each of the following on a scale from zero to ten, where zero means *not at all beneficial* and ten means *extremely beneficial*. [Presented in random order]

**[Reduced greenhouse gas emissions]** Fewer overall greenhouse gas emissions because nuclear energy production does not create greenhouse gases.

**[Reliable electrical power]** Reliable power because nuclear energy generates large amounts of electricity and is not affected by weather conditions, such as low rainfall or no wind.

**[Energy independence]** Greater U.S. energy independence because nuclear energy production does not require oil or gas from foreign sources.

**[Less mining / extraction]** Reduced environmental damage because of less need for mining coal or extracting oil and gas.

The responses to each question in 2014 and the comparison with the mean responses in 2013 are shown in Table 2.1.

<sup>3</sup> The term "used nuclear fuel" was used in all survey questions and is throughout the discussion. In current usage, the term "used fuel" or "used nuclear fuel" is applied to fuel that has been irradiated in a reactor and withdrawn but for which no decision has been made about whether it will be reprocessed to recover usable radionuclides, stored indefinitely, or disposed directly. However, U.S. laws and regulations dealing with storage and disposal use only the term "spent nuclear fuel" (SNF) for which a decision has been made related to disposition, even if only temporarily.

**Table 2.1 Mean Nuclear Risks and Benefits: 2013 vs. 2014**

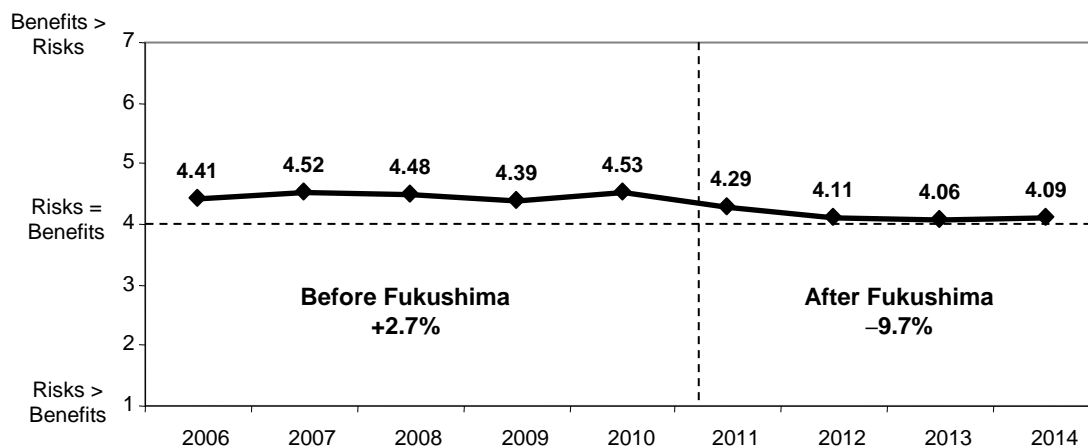
	2013	2014	<i>p</i> -Value
Nuclear Risks: 0 = No Risk — 10 = Extreme Risk			
Terrorist attack	6.93	7.06	.2710
Operational accident	6.68	6.81	.2778
Transportation accident	6.49	6.67	.1300
Diversion to nuclear weapons	5.95	6.14	.1522
Nuclear Benefits: 0 = Not At All Beneficial — 10 = Extremely Beneficial			
Energy independence	7.22	7.22	.9741
Less mining / extraction	7.02	6.95	.5285
Reliable electrical power	6.95	7.07	.2747
No greenhouse gas emissions	6.80	6.82	.8392

As shown in Table 2.1, the mean score for each of the perceived risk categories was above midscale, and average perceived risks in all categories have remained consistent across the 2013 and 2014 EE surveys. The small increases in the mean scores for perceived risks in 2014 were not statistically significant. We can see a similar pattern on the perceived benefit side, where the mean scores have remained largely consistent, and small average differences in the perceived benefits across the two years were not statistically significant.

Following the battery of nuclear risk and benefit questions, respondents were asked to provide their assessments of the aggregate balance of risks and benefits of nuclear energy. The question wording was:

Now please consider the overall balance of these possible risks and benefits of nuclear energy in the U.S. Using a scale from one to seven, where one means the risks of nuclear energy far outweigh its benefits, four means the risks and benefits are equally balanced, and seven means the benefits of nuclear energy far outweigh its risks, how do you rate the overall balance of the risks and benefits of nuclear energy in the U.S.? Remember, you can choose any number from one to seven.

Figure 2.1 shows the trend in the mean balance of perceived risks and benefits from 2006 through 2014.

**Figure 2.1: Trends in Balance of Nuclear Energy Risks and Benefits**

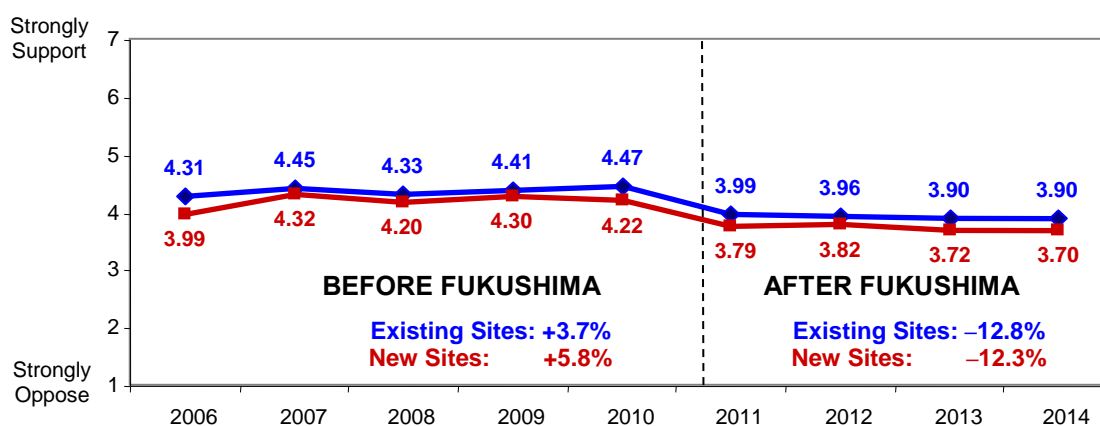
As is evident in Figure 2.1,<sup>4</sup> the balance between the perceived risks and benefits of nuclear energy has changed over time. From 2006-2010, survey respondents perceived the benefits of nuclear energy to be higher than the perceived risks. However, this trend began to shift after 2010. From that point on, respondents have viewed the risks and benefits of nuclear energy to be roughly equal. This pattern indicates the probable effects of the Fukushima accident in March of 2011.

In addition to measuring the risks and benefits that respondents associate with nuclear energy, the EE series has tracked public support for the construction of new nuclear reactors. Since 2006, the following questions have been asked in each of the EE surveys:

Using a scale from one to seven, where one means *strongly oppose* and seven means *strongly support*, how do you feel about constructing additional nuclear reactors at the sites of existing nuclear power plants in the U.S.?

Using the same scale from one to seven, where one means *strongly oppose* and seven means *strongly support*, how do you feel about constructing additional nuclear power plants at new locations in the U.S.?

Figure 2.2 shows the trends in mean responses to these two questions over the 2006-2014 period. The blue trend line shows mean support for new reactors at the site of existing nuclear power plants; the red line shows support for new reactors at new locations.



**Figure 2.2: Trends in Support for New Reactors at Existing and New Sites**

As seen in Figure 2.2, public support for new nuclear reactors was rising from 2006-2010, but fell below midpoint on the 7-point scale in 2011 and remained below midpoint in subsequent years. This reduced support coincides with the nuclear event at Fukushima in 2011. It should be noted that our survey in May 2011 was fielded just two months after the Fukushima event. Results from EE14 show that the support for new construction, whether at existing reactor sites or new ones, remains at an all time low.

The trends highlighted in Figures 2.1 and 2.2 have implications for public preferences regarding the future role of nuclear energy in the U.S. To measure and track these implications, the EE14 survey posed a set of questions about the preferred proportion of fossil, renewable and nuclear energy sources in the

<sup>4</sup> The percentage increase and/or decrease calculated in this and subsequent figures is calculated as follows: the difference between the reference number and the comparison number is found; the difference is divided by the original number; the result is multiplied by 100. As an example, in Figure 2.1, the -9.7% After Fukushima was calculated as:  $4.47 - 3.90 = 0.57 / 4.47 = 0.128 \times 100 = 12.8\%$ .

September 2014

overall energy mix for twenty years into the future. As a baseline, respondents were informed about the current proportions of energy derived from those three sources. The question was posed as follows:

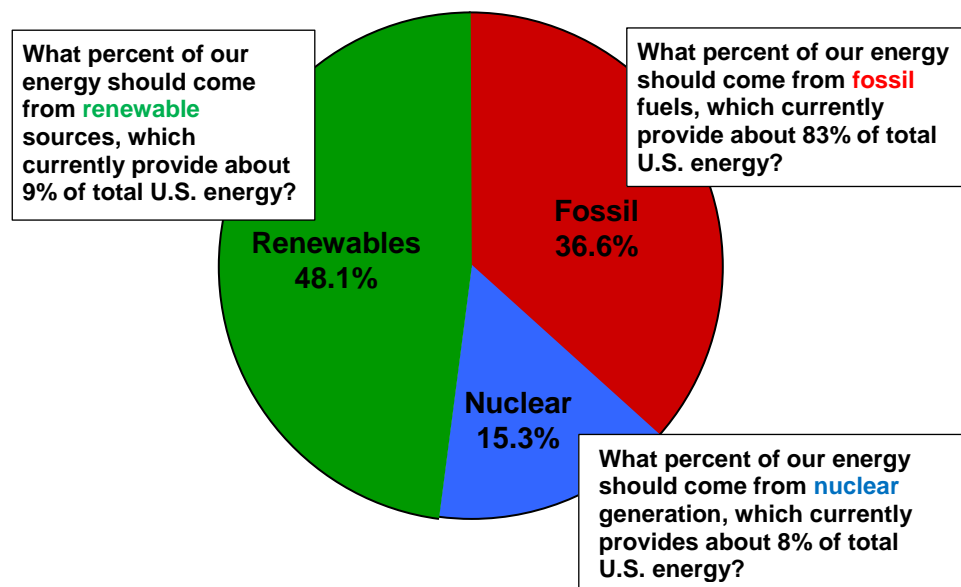
Now think about the overall mix of all sources of energy for the U.S. We currently get about 83 percent of our energy from fossil fuels, 9 percent from nuclear energy, and 8 percent from renewable sources (hydroelectric dams, wood, biofuels, wind, waste products, geothermal, and solar). We want to know approximately what percentage of the total U.S. energy supply over the next 20 years you would like to see come from each of these three primary sources. [Presented in random order:]

What percent of our energy should come from fossil fuels, which currently provide about 83% of total U.S. energy?

What percent of our energy should come from nuclear energy, which currently provides about 9% of total U.S. energy?

What percent of our energy should come from renewable sources (hydroelectric dams, wood, biofuels, wind, waste products, geothermal, and solar), which currently provide about 8% of total U.S. energy?

The percentages from the 2014 respondents are shown in Figure 2.3.



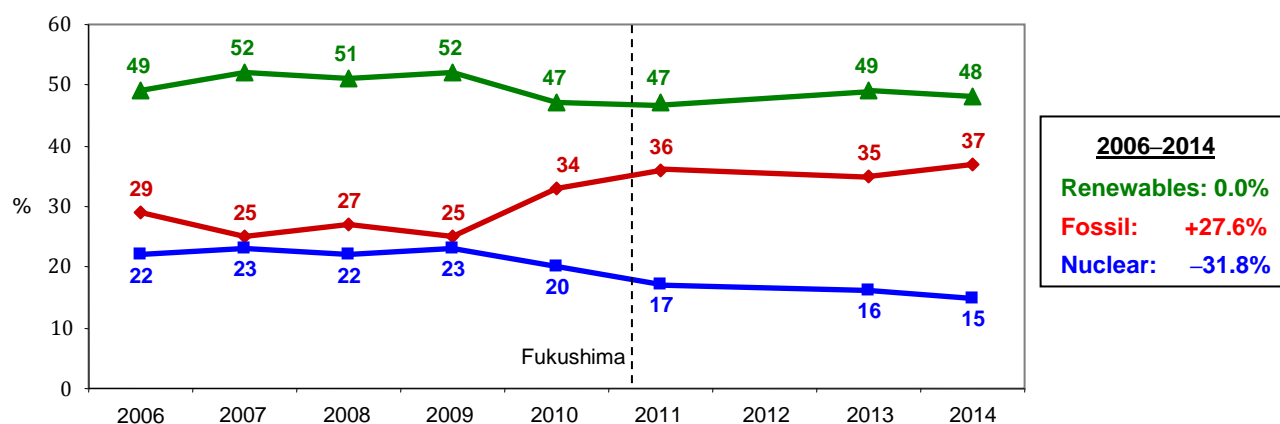
**Figure 2.3: Preferred Sources of U.S. Energy Over the Next 20 Years**

Figure 2.3 indicates that, when informed about current sources, the EE14 respondents preferred to have the nuclear share of U.S. energy rise from approximately 8% to 15.3%. On average our respondents preferred that, by the year 2034, fossil fuels should account for 36% of the U.S. energy mix, which is significantly lower than the current share of 83%. The preferred share of renewables rose from the current share of 9% to 48%.

This is somewhat surprising given the rise in perceived risk of nuclear energy over the last few years and the decrease in public support for new nuclear reactors. This finding may, in part, be driven by the public's strong desire to decrease U.S. reliance on fossil fuels. As indicated above in Table 2.1, the greatest perceived benefit of nuclear energy is its contribution to energy independence, and these benefits have not diminished in recent years despite the concerns about the Fukushima event.



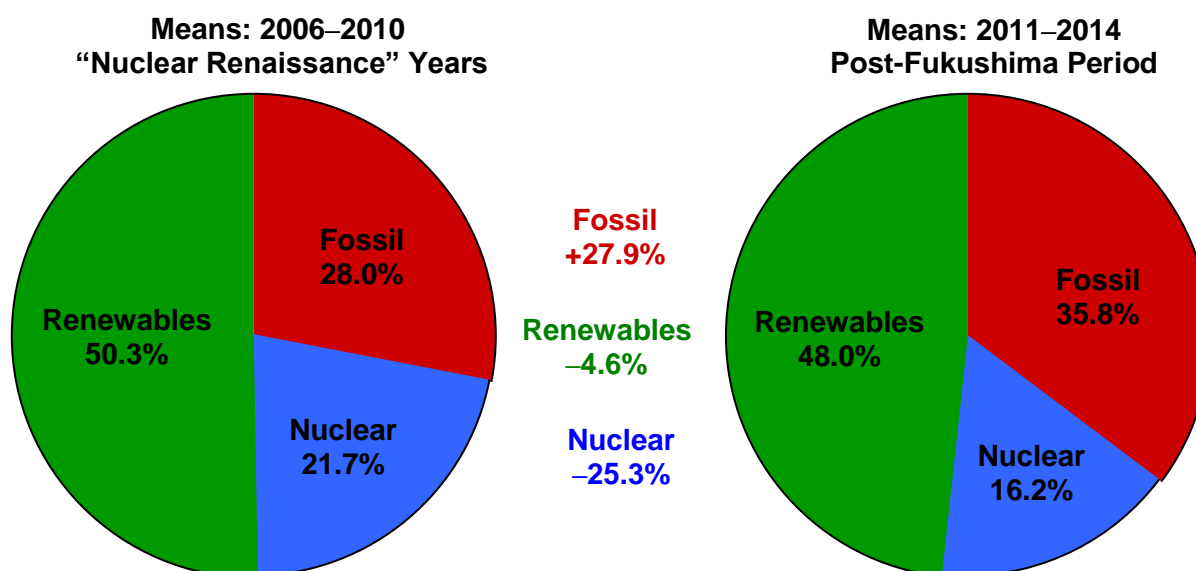
The expressed preference for a near doubling of the share of nuclear energy over 20 years – from 8% to 15.3% - indicates that members of the public see a continuing and important role for nuclear energy in spite of the rise in perceived risks since 2011. We should note, however, that the preferred percentage of the total energy mix that comes from nuclear energy has been slowly declining since 2009 (the average percentage that respondents preferred in 2009 was 23%). This trend over time in preferred sources of energy is shown below in Figure 2.4. The preferred proportion of total future energy from nuclear reactors has declined by nearly a third, falling from 23% in 2009 to 15% in 2014. The preferred proportion of fossil fuel jumped from 25% to 37% over the same period.



**Figure 2.4: Preferences for Sources of Future Energy Supply (% Preferred from Each Source)**

The Fukushima event appears to have influenced this preference, particularly in comparison to the earlier period often referred to as the “nuclear renaissance.” As shown in Figure 2.5, the percentage of total energy supply that respondents want to see provided by nuclear reactors in the future dropped from 21.7% over the 2006-2010 “nuclear renaissance” period to 16.2% in the post-Fukushima period. Nevertheless, it is important to note that while preferences for reliance on nuclear energy have declined, survey respondents continue to prefer that it play an important role in the country’s energy mix in the future.

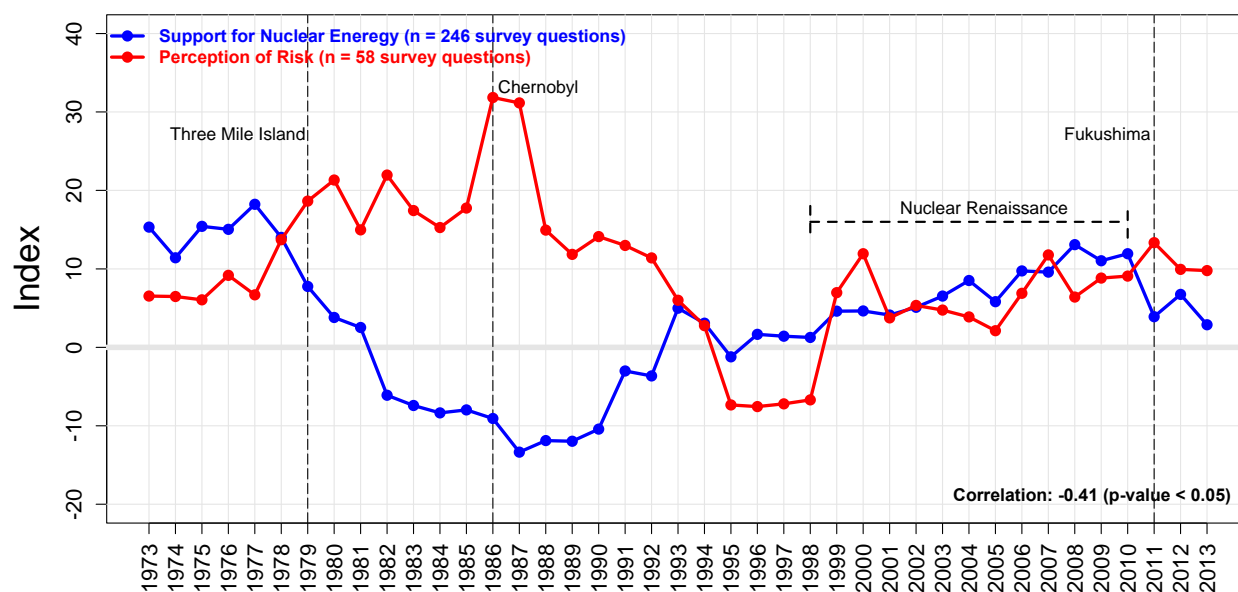




**Figure 2.5: Mean Preferred Future Energy Mix: Before and After Fukushima**

As we consider these recent trends, it is important to keep in mind that Americans’ attitudes toward nuclear energy have fluctuated considerably over the last 5 decades, and are likely to continue to do so in response to new information, events, and circumstances. Figure 2.6 shows the results of a meta-analysis of changes in the perceived risks of, and support for, nuclear energy among U.S. residents from the 1970s to 2013.<sup>5</sup> This analysis is based on all publicly available U.S. population surveys taken from 1973 to 2013, for which average support and the balance of perceived risks in each survey are calculated. The trend evident in all of these surveys provides a longer time series of public risk perceptions and support for nuclear energy. The trend indicates that support dropped (and perceived risks rose) markedly in the late 1970s, bottoming out after the Chernobyl nuclear accident. Support gradually rose (though perceived risks remained above midscale) over the next several decades, coinciding with the “nuclear renaissance” period which spanned the first decade of this century. The meta-data also show that, after a period of relative support for nuclear energy, support declined (and perceived risks rose) on the heels of the Fukushima nuclear accident in March 2011. In the last few years since the Fukushima accident, the plot shows that while perceptions of risk have begun to plateau, support for nuclear energy continues to decline.

<sup>5</sup> The data in Figure 2.6 are updated from those discussed in Jenkins-Smith et al. 2013.



**Figure 2.6: Analysis of Long-Term Trends in U.S. Public Attitudes about Nuclear Energy (1973-2013)**

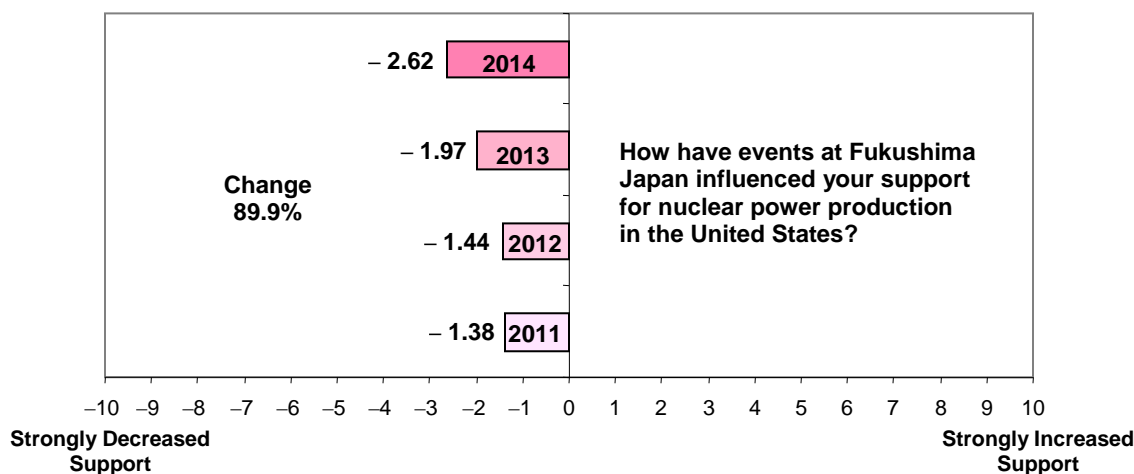
## 2.2 Implications of Fukushima for Nuclear Attitudes

Recent and ongoing events like Fukushima can have a lingering effect on the future of nuclear energy, especially in the minds of the public. Beginning in May 2011, the EE surveys have tracked this effect by posing direct questions to respondents about the extent to which the Fukushima event has influenced their support for nuclear power production in the U.S. Before posing the question, respondents were primed to the event using a brief description of what happened on the day of the accident. This ensures that all respondents had basic information about the event before they answered questions about it. The question was worded as follows:

As you may recall, a severe earthquake occurred on March 11, 2011 in the Pacific Ocean near Japan, creating large tidal waves that destroyed some Japanese coastal cities. Also damaged was the Fukushima nuclear power plant, which released radioactivity into the atmosphere and nearby portions of the sea. The earthquake and tidal wave killed thousands of people; the release of radiation at Fukushima is not known to have produced any deaths, but could contribute to future illnesses. We would like to know how the Japanese experience has influenced your confidence in U.S. nuclear power.

On a scale from minus ten to plus ten, where minus ten means the Japanese experience has *strongly reduced* your support for U.S. nuclear power production, zero means the Japanese experience has had *no effect* on your support, and plus ten means the Japanese experience has *strongly increased* your support, how have recent events in Japan influenced your support for nuclear power production in the United States?

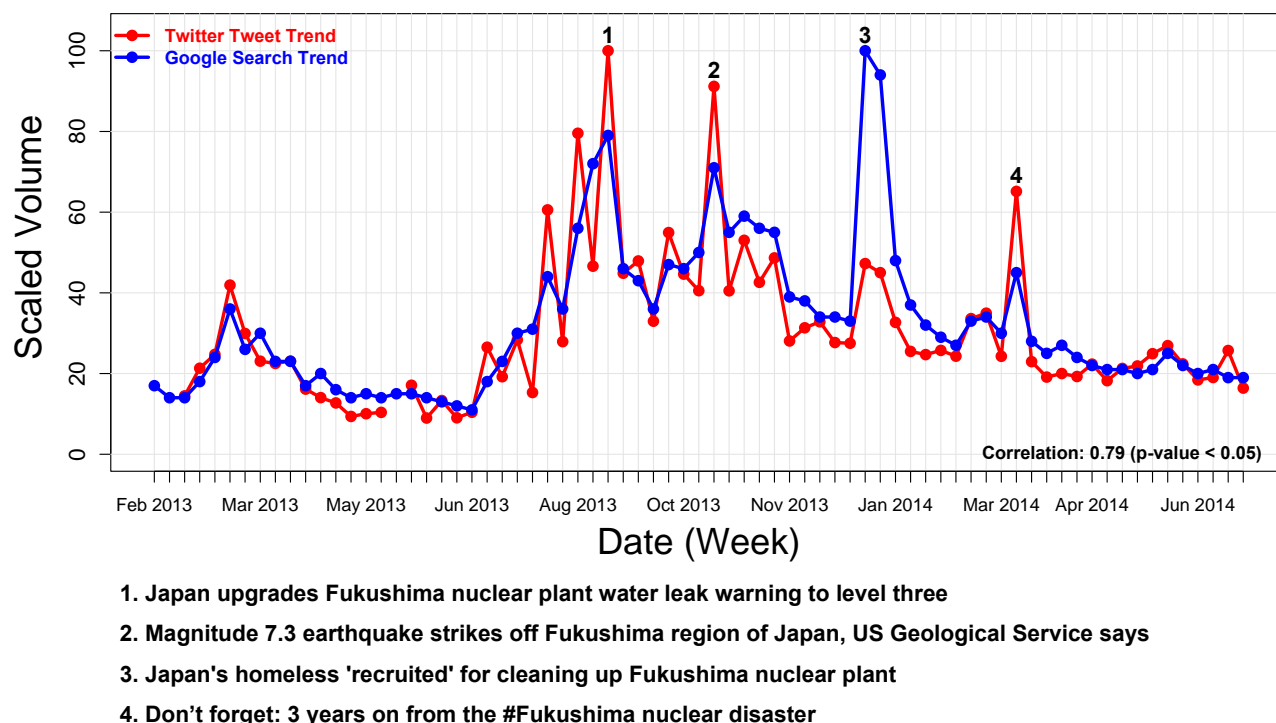
The average self-assessed effect of the Fukushima event on support for reliance on nuclear energy in the U.S., in each of the four years since the event, is shown in Figure 2.7.



**Figure 2.7: Mean Effects of Fukushima on U.S. Public Support for Nuclear Energy: 2011 through 2014**

As shown in Figure 2.7, the average responses indicate that, over time, the Fukushima accident has had a growing negative effect on public support for nuclear power in the U.S. The decline in support has ranged from a downward shift of 1.38 points after the event in 2011 to a 2.62-point drop in 2014. This trend provides a direct indicator of the lingering effects of an event like Fukushima on support for nuclear energy. It is important to note that these opinions are not formed in a vacuum, nor are they uniform. In fact, 13% of the respondents in 2014 indicated that the Fukushima event *increased* their support for nuclear power production in the U.S., and 33% said that the event neither increased nor decreased their support.

In addition to measuring the self-assessed effects of the Fukushima accident using the EE surveys, CES&S also monitors continued attention to the event in the form of social media posts and Internet search queries by the public. Trends in each of these areas are shown (by week) for the period between February 2013 and June 2014 in Figure 2.8.



**Figure 2.8: Twitter Tweet Trends and Google Search Trends for “Fukushima” Between February 2013 and June 2014**

The trends in Figure 2.8 show the co-evolution of Twitter tweet trends (red line) and Google search trends (blue line) related to “Fukushima” between February 2013 and June 2014. The patterns are notable for several reasons.<sup>6</sup> First, the trends move in unison, with the volume of Twitter traffic and Google searches tending to rise and fall in tandem. The four peaks highlighted in the figure above demonstrate this co-variation. For example, in August 2013, both Twitter and Google experienced a surge in traffic in response to a new radiation leak discovered at the Fukushima nuclear plant. Similarly, the third anniversary of the Fukushima accident saw a rise in the volume of traffic for both sources. More importantly, these trend lines indicate that members of the U.S. public are continuing to think about and discuss the Fukushima nuclear event three and even four years after it occurred. This corroborates the notion that focusing events like Fukushima can have lingering effects on public opinions about nuclear energy.

## 2.3 Implications of Climate Change for Nuclear Attitudes

Events like Fukushima have an influence on public support for nuclear power, but they are just one of the factors that shape overall opinions about nuclear energy. Another potentially long-term influence is that of the debate over the implications of climate change. As shown in section 2.1, public support for nuclear energy has declined in the last few years. Is it possible that the climate-friendly nature of nuclear energy – inasmuch as it produces substantially less carbon dioxide than does energy generation using fossil fuels

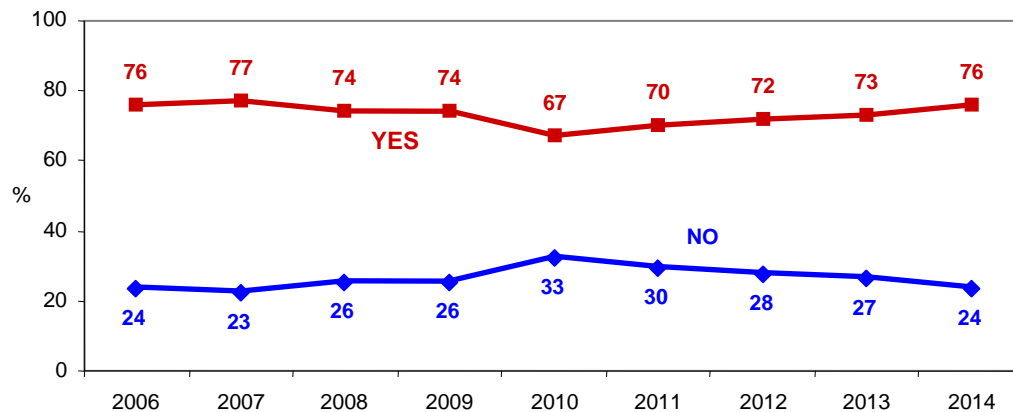
<sup>6</sup> The scale values are based on percentages of the maximum weekly count for each trend. For the Twitter traffic, a total of 4,045,105 tweets containing the word “Fukushima” were collected between February 2013 and June 2014, with a maximum weekly count of just over 190,000 tweets.

(Coleman et al 2013) – can shift these opinions and lead to increased support? To answer this question, the EE14 survey included questions about respondents’ perceptions of climate change. First, respondents were asked the following question:

As you may know, the issue of global climate change has been the subject of public discussion over the last few years.

In your view, are greenhouse gases, such as those resulting from the combustion of coal, oil, natural gas, and other materials causing average global temperatures to rise?

Consistent with other surveys of the U.S. public, a large majority of the respondents to the EE14 survey believe that human-generated greenhouse gases (GHGs) are causing the climate to change. Figure 2.9 shows the trends in the proportions of the EE14 respondents who do, and do not, believe that human activity is causing climate change since 2006.

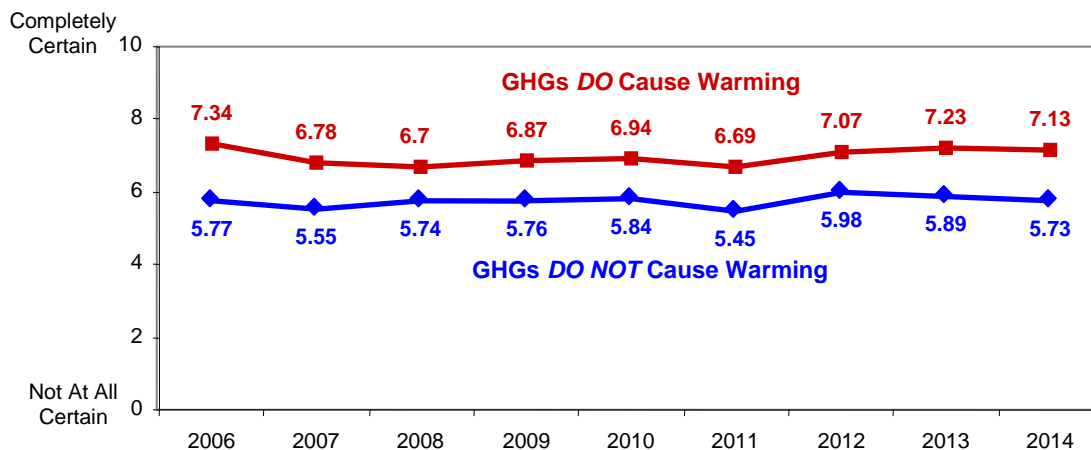


**Figure 2.9: Public Opinion About the Occurrence of Anthropogenic Climate Change**

As shown in Figure 2.9, the percentage of respondents who believe that GHGs are causing climate change has been steadily increasing since 2010. Responses to EE14 indicate that 76% of respondents believe that GHGs are causing climate change as opposed to 24% who think they are not. Following this question, respondents were asked about the level of certainty they attach to this belief:

On a scale from zero to ten, where zero means *not at all certain* and ten means *completely certain*, how certain are you that greenhouse gases [are/are not] causing average global temperatures to rise?

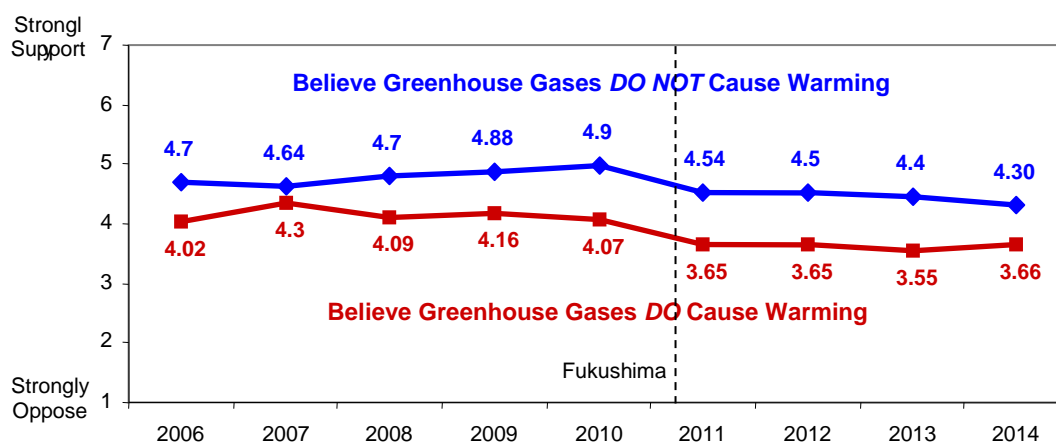
The responses to this question are shown in Figure 2.10—the trend over time reveals that on a certainty scale ranging from 0 (“not at all certain”) to 10 (“completely certain”), those who believe that climate change is resulting from anthropogenic GHGs have consistently been more certain (by 1 to 1.5 points) than those who do not.



**Figure 2.10: Public Certainty about the Occurrence of Anthropogenic Climate Change**

In sum, a substantial majority of respondents have consistently expressed the belief that the climate is changing in response to human generated GHGs, and that majority is (on average) fairly certain about their belief. Does this belief translate into support for nuclear energy?

Figure 2.11 provides a partial answer to this question. For each year of the EE survey results, the figure plots the mean level of support for new nuclear reactors among those who do, and do not, believe that climate change is resulting from human-generated GHGs. Consistently over the series, those who believe that the climate is changing as a result of anthropogenic greenhouse gases are significantly *less* supportive of new nuclear reactors than are those who do not. In other words, beliefs about climate change do *not* seem to induce support for nuclear energy. Indeed, the belief that humans are causing the climate to change is associated with *less* support for nuclear energy, in spite of the current and potential future role of nuclear energy in reducing greenhouse gas emissions.



**Figure 2.11: Climate Change Beliefs and Support for New Nuclear Reactors**

Why is this the case? Most broadly, belief in climate change is strongly associated with underlying attitudes about the environment that also affect perceptions about the risks and benefits of nuclear energy. People who think that the environment is fragile and easily harmed by human activities also tend to believe that anthropogenic greenhouse gases are causing the climate to change. At the same time, due in

part to their beliefs about the fragility of nature, this same group of people is *less* likely to be supportive of nuclear energy, which they view as environmentally risky.

In aggregate, as discussed in this section, multiple streams of evidence indicate that the continuing attention to Fukushima, coupled with its negative implications for public support for nuclear energy, has changed the context in which nuclear facility siting efforts will occur. Concerns about climate change, in turn, are currently rooted in general attitudes about the environment that have traditionally been unreceptive to nuclear energy. These trends color the broader context in which discussions of siting nuclear facilities will take place. Keep in mind however that, as illustrated in Figure 2.6, perceived risks and support for nuclear energy are subject to change over time. Consent-based siting programs will need to be sufficiently flexible to adapt to those changes.

### 3. EVOLVING PUBLIC AWARENESS OF THE UNF CYCLE

Consent-based siting programs are designed to achieve a number of interrelated intermediate and long-term goals. In the intermediate term, consent-based siting programs are devised to engage a broad range of important stakeholders, increase awareness among the public, foster open communication, and disseminate relevant information about the siting process in an open and transparent manner. In the longer term, the accomplishment of these intermediate goals is intended to increase community trust in the process and, ultimately, the level of community acceptance and ownership of the outcome produced by the process. In order to successfully initiate such a program, officials must begin by asking—what kind of background knowledge and understanding of the relevant aspects of the nuclear fuel cycle can be expected of the public?

The EE14 survey contained a number of questions intended to gauge public background knowledge and awareness of aspects of nuclear energy, UNF, and current nuclear waste policy. The questions in this set included those shown in Table 3.1.

**Table 3.1: Public Awareness and Knowledge of the U.S. Nuclear Fuel Cycle**

Knowledge Measure	% Correct Responses
Is your primary residence located within approximately 100 miles of an operating nuclear power plant?	45
What currently is being done with most of the used nuclear fuel produced in the U.S.? (Correct answer: temporary on-site storage)	35
Is your primary residence located within approximately 100 miles of a site where used nuclear fuel is being stored?	25
Have you heard or read about the Waste Isolation Pilot Plant (WIPP), located in southeastern New Mexico?	8

The most basic measure of background knowledge concerns whether respondents know how close their primary residence is to an operating nuclear power plant. When asked whether they lived within 100 miles of an operating plant, less than half responded correctly (29% said they did not know; 26% gave an incorrect answer).<sup>7</sup> The percentage of people who knew whether their residence was within 100 miles of a site where UNF is stored was much lower at only 25%. Furthermore, only 35% were able to correctly identify on-site storage as the most common practice for storing UNF. On a related note, when asked about WIPP, the nation's only licensed deep-geologic repository, only 8% of respondents reported that they had ever heard of it.

On average, our respondents were able to answer relatively few of these basic background knowledge questions correctly (on average, respondents could answer only 1.1 of the four questions correctly). This suggests that the broader public is not well informed about nuclear energy or nuclear waste issues. This has important implications for siting nuclear facilities. Facility siting in the absence of broadly disseminated knowledge about nuclear issues will likely result in a default reliance on the very broad beliefs and risk perceptions described in Section 2 of this report. As we noted earlier, notable current trends will pose challenges for nuclear facility siting efforts.

<sup>7</sup> The location of respondents' residences was recorded either using geo-location of their device or (where location identification permission was not given by the respondent) by utilizing the respondents' residential zip codes. Using this location data, the distance to the nearest operating nuclear power plant was calculated. This method was also used to calculate the respondents' proximity to the nearest temporary UNF storage site.



Sparse knowledge about nuclear issues among the public also has implications for how we can go about measuring public preferences for nuclear policy options. When faced with this kind of policy-specific knowledge deficit when inquiring about policy preferences in a survey of the public, balanced<sup>8</sup> background information must be provided to enable respondents to reasonably consider the issue and provide meaningful responses. Most of the specific UNF policy questions asked in the EE14 survey and described in the remainder of this report provided such background.

In light of these findings, it is clear that communication and engagement programs will need to consider engagement with members of the public who are not well informed about nuclear energy and nuclear waste issues. Furthermore, it is quite likely that during the siting process there will be an array of stakeholders seeking to inform and influence the public, and some will likely provide conflicting kinds of information (Jenkins-Smith and Silva 1998). And, despite the policy specific knowledge deficits described here, members of the public are very discerning about the potential biases of the different actors who are purveyors of policy information. Designing and building a robust, trustworthy basis for communication and engagement – one that is understood by the public to be as concerned about the interests of potential host communities as it is about siting a facility – will therefore be of critical importance to the success of the consent-based siting program.

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<sup>8</sup> In the context of survey research, “balanced” information means that the background provided captures the range of expressed options and claims that the respondent is likely to encounter in a normal exposure to the public debate on the issue. Therefore when considering policy options, background information is often provided in the form of summary arguments made by both proponents and opponents of the option. See the *Reference Report* for the full background descriptions and question wording used in the EE14 survey.

## 4. PUBLIC UNDERSTANDING AND PERCEPTIONS OF INTERIM STORAGE

Given that most members of the public know relatively little about nuclear fuel cycle issues, measuring informed opinion and preferences is challenging. Our approach is to provide the respondents with background on the issues, using as our guide the kinds of claims and arguments raised by policy advocates on multiple sides of the policy debate. In this way, the EE14 survey respondents received a condensed and somewhat simplified version of the kinds of arguments that they will hear in an actual policy debate.<sup>9</sup> To illustrate how this was accomplished, one portion of the survey is designed to elicit preferences about how the U.S. should store UNF—continue on-site storage or build interim storage facilities. To elicit meaningful preferences, we provide respondents with the following background information and then ask them to answer a set of related questions:

**Now we need to provide essential information for you to consider before answering additional questions. We ask that you read the following three paragraphs carefully so that everyone taking the survey has the same minimum level of factual information.**

Used nuclear fuel is highly radioactive and must be safeguarded for thousands of years or chemically reprocessed, which is not economically feasible in the U.S. today. In 2010 the government halted construction of a deep underground facility inside Yucca Mountain in Nevada that had been intended for permanent storage and disposal of used nuclear fuel.

Currently, used nuclear fuel in the U.S. is stored at more than 100 temporary storage sites in 39 states. This used fuel is stored in cooling pools “on-site” at nuclear power plants and decommissioned facilities. As part of the nation’s used nuclear fuel storage policy, the government is trying to decide whether this used fuel should continue to be stored on-site, or whether it should be transported to interim storage facilities until a permanent repository can be constructed.

[Random order for grouped sets of bulleted arguments]

Key arguments that are made FOR current “on-site” storage practices include the following:

- Keeping the used nuclear fuel at current facilities until a permanent repository is constructed would ensure that the radioactive materials have to be moved only once instead of twice.
- Packaging and transportation of U-NF from nuclear facilities to interim storage facilities is risky.
- Storing fuel “on-site” at nuclear facilities is less expensive than building interim storage facilities and buys time for finding permanent future solutions.
- Current storage at nuclear power plants has not caused any accidents that have exposed the U.S. public to radiation, and with significant investment, current storage sites can be made safer from terrorists and other threats such as flooding.

Key arguments that are made AGAINST current “on-site” storage practices include the following:

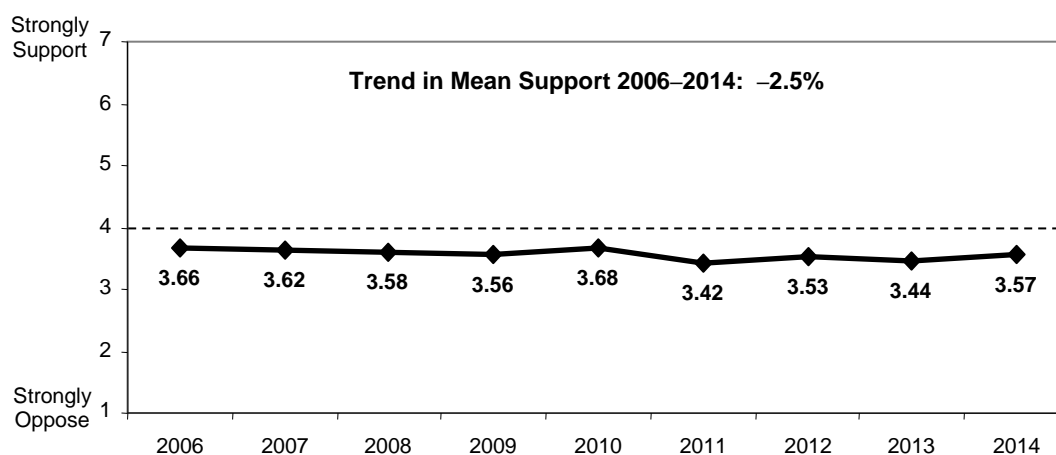
- Storing used nuclear fuel at nuclear facilities does not provide adequate protection from terrorists, and increasing security would require substantial effort, time, and money.
- Some nuclear power plants where used nuclear fuel is stored are near rivers and oceans where flooding is possible, and many are near large population centers, making huge numbers of U.S. residents vulnerable to risks from flooding and other accidents. On rare occasions, used nuclear fuel has leaked radiation into the cooling pools.

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<sup>9</sup> We also evaluate these arguments for technical validity by having the survey questionnaires reviewed by technical experts in fuel cycle issues at Sandia National Laboratories (SNL). University of Oklahoma faculty and staff make all final decisions about question wording, and the University of Oklahoma’s Institutional Review Board approves all questions for human subjects application.

- Large volumes of these materials are accumulating that require expensive security; yet current practices do not provide a permanent solution.
- Some of these sites have been dismantled or shutdown, resulting in “stranded” used nuclear fuel. Expensive security measures must be maintained to protect these stored nuclear materials. Interim storage facilities could help consolidate this used fuel.

As shown below in Figure 4.1, public preferences for continued on-site storage were remarkably stable from 2006 through 2010, with average support falling below midscale. In May 2010, 40% of the survey respondents opposed continued on-site storage, 33% were unsure, and 27% were in support. Beginning at the 2011 survey, which was administered 2 months after the Fukushima nuclear event, public support for continued on-site storage declined still further. By 2013, nearly half (49%) opposed continued on-site storage, and only 22% supported continuation of the practice. Results from EE14 indicated that about 43% still opposed continued on-site storage, 31% were unsure, and only 26% supported the current practice.



**Figure 4.1: Support for Continued On-Site Storage of UNF**

To elicit public preferences for greater reliance on interim storage, respondents received the following background information and key arguments made by competing stakeholders before answering the question at the end:

Though nuclear power plants will continue to store some used nuclear fuel in their cooling pools, much of the radioactive materials currently at more than 100 temporary storage sites in 39 states could be consolidated at a smaller number of facilities. The President’s Blue Ribbon Commission on America’s Nuclear Future recognized that constructing underground repositories for permanent storage and disposal of used nuclear fuel will take decades, and the Commission recommended building interim storage sites in the next 10-15 years where used nuclear fuel could be consolidated, stored, and better secured while one or more permanent nuclear repositories are being developed. These interim storage sites would meet all technical and safety requirements set by the U.S. Nuclear Regulatory Commission, the U.S. Environmental Protection Agency, and state regulatory agencies.

[Random order for grouped sets of bulleted arguments]

Key arguments that are made FOR interim storage sites include the following:

- Interim sites can be constructed sooner (within 10-15 years) to safely store used nuclear fuel for up to a hundred years, which is longer than feasible for temporary storage at nuclear power plants, and allow more time to develop permanent repositories.

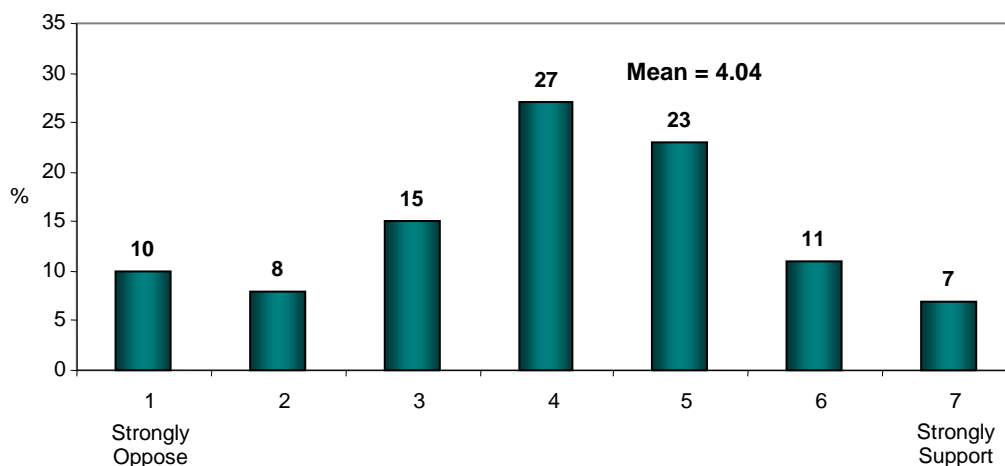
- Interim sites would consolidate used nuclear fuel while providing better protection from terrorists and allowing the radioactive materials to cool and be packaged for eventual shipment to a permanent repository.
- Interim sites would reduce the growing amount of radioactive materials currently being stored at nuclear power plants, many of which are near large population centers, rivers, and oceans where flooding is possible.
- Interim sites would allow removal of “stranded” used nuclear fuel from ten sites and eventually other sites where nuclear reactors have been dismantled or shutdown, but expensive security measures must be continued to protect the stored nuclear materials. Those savings could partially pay for constructing interim storage sites.

Key arguments that are made AGAINST interim storage sites include the following:

- Building interim sites might lead to delaying the more politically difficult solution of building permanent repositories, which may take 30 or 40 years to construct.
- Transporting used nuclear fuel by barge, train, or truck to interim sites is more risky than continuing temporary storage at the sites of operating or dismantled nuclear power plants.
- Expanding current “on-site” storage practices at or near *existing* operational nuclear power plants is cheaper and politically more acceptable than building consolidated interim storage facilities.
- No members of the public have yet been harmed by current practices for temporarily storing used nuclear fuel, and even though many of today’s sites are near large population centers, security can be improved to reduce the risks of terrorist attacks and flooding.

Using a scale from one to seven, where one means *strongly oppose* and seven means *strongly support*, how do you feel about constructing one or more interim storage facilities for consolidating used nuclear fuel in the U.S.?

The answers to this question provided by the 2014 survey respondents are shown in Figure 4.2. As evidenced by the figure, 41% supported the construction of one or more ISFs, 33% opposed, and 27% were unsure, suggesting that EE14 respondents were slightly more supportive of interim storage (mean = 4.04) than on-site storage (mean = 3.57).



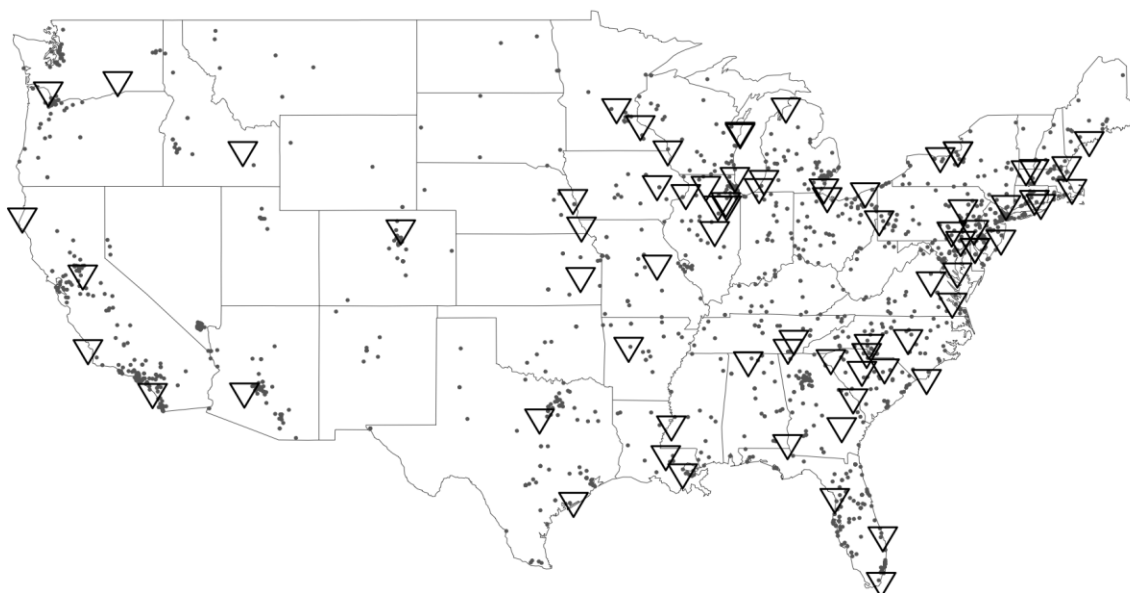
**Figure 4.2: Public Preferences for One or More Interim UNF Storage Facilities**

#### 4.1 Proximity to Temporary UNF Storage and Prospective ISF Storage

Along with broad beliefs about nuclear energy, risk and benefit perceptions, as well as beliefs about climate change, one key factor that defines the context within which individuals make decisions about

facility siting is likely to be *proximity*. How far away will the proposed ISF be? How close is the nearest temporary storage facility that currently holds UNF? The EE14 survey was designed to consider both aspects of proximity.

When survey respondents were invited to participate in the EE14 survey, they were asked for permission to use their location information.<sup>10</sup> Figure 4.3 shows the approximate location of each survey respondent (each point on the map), and for comparison, the location of current temporary UNF storage sites (triangle). About 76% of population and 2014 respondents reside within 100 miles of a UNF storage site, while 44% of the population and 42% of 2014 respondents reside within 50 miles.



**Figure 4.3: Location of EE14 Respondents and Temporary UNF Storage**

The respondents' location data were used in the survey to provide respondents with an estimate of the distance of their residence to the nearest UNF storage site, using the following language:

Based on the location information you provided, we estimate that your primary residence is approximately [insert estimate] miles (straight line) from the nearest nuclear energy facility where used nuclear fuel currently is in temporary storage. Our estimate could be imprecise, but you can see the big picture by looking at this map showing where used nuclear fuel currently is being stored in the U.S. [A map of UNF storage sites within the US was shown].

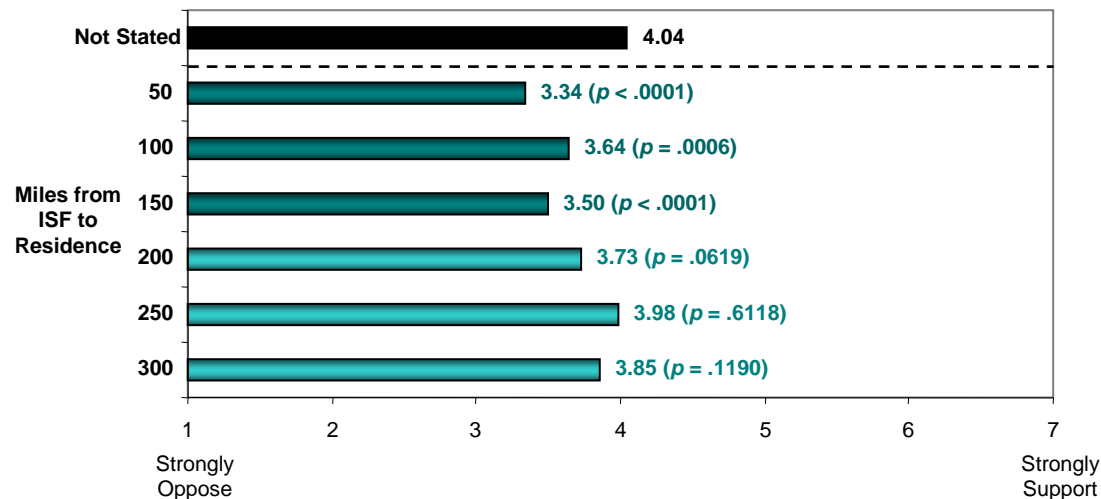
In addition to providing distance to the nearest UNF storage site, we experimented with hypothetical distances to a proposed new ISF. After asking respondents about their general level of support for constructing one or more ISFs (see results in Figure 4.2), we posed the following question:

Now assume that this interim storage facility is to be located (*respondents were assigned at random to one of the following distances: 50, 100, 150, 200, 250, 300*) miles from your primary residence.

How do you feel about constructing this type of interim storage facility? [*Responses were recorded on a scale ranging from 1 ("strongly oppose") to 7 ("strongly support")*].

<sup>10</sup> If permission was provided, location information was obtained either directly by their Internet browsers, their IP address, or by user-entered zip codes.

The effect of the randomly assigned distances to a prospective ISF was modest but statistically significant: the smaller the distance, the lower the average level of support. This relationship in contrast to the pattern of responses *without* reference to proximity to an ISF (shown in black) is illustrated in Figure 4.4. The statistical significance of the differences in support at each distance, and without reference to distance, is shown in the figure. The average level of support for respondents when no proximity was specified was 4.04, and this level of support fell to 3.34 when respondents were told that the facility would be sited 50 miles away.



**Figure 4.4: Respondents' Support for Basic ISF Concept Before and After Being Told Hypothetical Proximity**

As indicated by the figure, the effects of proximity are somewhat subtle and difficult to observe in the relatively small experimental groups available for this analysis. However, when both distance to the prospective ISF and distance from existing UNF temporary storage are simultaneously used to predict support, both have a statistically significant influence.<sup>11</sup> The closer the respondent's residence is to an existing UNF storage site, the greater (on average) is the support for construction of one or more ISFs. The closer the respondent is to the prospective ISF, the lower is the support for building the ISF. Table 4.1 shows the model estimates of the effects of proximity to existing UNF storage, and to the prospective ISF, on support for siting the facility.

<sup>11</sup> These relationships were estimated using ordinary least squares (OLS) regression. Note that the model estimates are derived using weighted data.

**Table 4.1: Estimated Effects of Current Proximity to UNF and Distance from Prospective ISF**

Mean Estimated Support (1=Strongly oppose, 7=Strongly support)	Distance to Prospective ISF			
	50 Miles	100 Miles	200 Miles	300 Miles
<b><i>Proximity to Existing UNF Storage</i></b>				
Reside 25 miles from existing UNF	3.51	3.62	3.84	4.06
Reside 50 miles from existing UNF	3.46	3.57	3.79	4.00
Reside 75 miles from existing UNF	3.41	3.51	3.73	3.95
Reside 100 miles from existing UNF	3.35	3.46	3.68	3.90

Based on the EE14 survey data, an average respondent living 25 miles from an existing UNF storage site would tend to oppose siting an ISF within 50 miles of their home. Estimated support becomes greater the farther the prospective ISF is from the respondents' homes. The same is true of respondents who live 100 miles away from an existing storage site—opposition decreases as distance to the prospective ISF increases. However, for these respondents, initial support for the prospective facility never rises to the midpoint (4) on the support scale.

It is important to note that this exercise in estimating the effects of proximity and distance on support for an ISF is useful for evaluating *general* effects among a population that has not yet engaged with siting officials and other stakeholders on the issue of siting an ISF. Specific effects of distance and proximity are likely to vary by region and by other population characteristics. Also, just like in the case of effects of the Fukushima accident and climate change on nuclear attitudes, proximity is but one variable that may explain individual support for nuclear facility siting. More importantly, as engagement over the siting issue proceeds over time, it is likely that levels of public support will change. In the case of the Waste Isolation Pilot Plant (WIPP), analysis of surveys taken over time in the 1990s showed that average public support for the facility grew considerably over time, and that support was consistently greatest near the proposed facility (Jenkins-Smith et al., 2011). But as the next section will illustrate, the recent WIPP incident may influence the level of support that facility or similar ones would receive in the future. A similar (though less widespread) effect of proximity was seen in the case of the proposed Yucca Mountain repository, though a majority of the Nevada public persistently opposed opening the repository (Dunlap et al., 1993; Flynn and Slovic, 1995).

In summary, the EE surveys indicate public reluctance to continue to rely on temporary on-site storage of UNF, and moderate support for developing one or more ISFs. When respondents are informed of their proximity to existing UNF storage, those who live closest to current sites tend to be more supportive of siting ISFs. However, that support is also conditional on how proximate their residence is to the proposed ISF. These factors are likely to influence the initial public responses to ISF siting issues, and should be anticipated by program officials in the early stages of consent-based siting efforts.

## 4.2 Measuring the Value of Interim Storage Options

As previously discussed, our respondents expressed greater support for consolidating UNF in ISFs than for continued reliance on temporary on-site storage. To design, site and construct one or more ISFs will of course require significant public investment. While the public prefers, on average, to shift UNF from temporary storage sites to ISFs, public willingness to commit the necessary resources to do so is less clear. Do Americans support expenditures of public money to build and utilize ISFs? Would individual families be willing to forego other kinds of expenditures and investments to pay for such a policy shift?



In this section we report findings from an experiment in which contingent valuation (CV) methods are employed for estimating public willingness to pay for a hypothetical national program to either (a) invest in siting and building ISFs or (b) continue temporary storage with investments in increased safety and security. As described below, we employ the CV approach because it provides a well-tested method for eliciting individuals' willingness to pay for goods that are not readily traded in markets. We also incorporate an experiment that allows us to evaluate whether a "base ISF" (i.e., one that is designed for storage only) is valued differently than an "enhanced ISF" (i.e., one that includes a repackaging and a research facility).

Efforts to determine whether policy options and programs are in the public interest require that benefits to the public be compared with costs of the program. The U.S. has long required that all major policies be evaluated using benefit/cost analysis to determine whether benefits outweigh costs (Graham, Johansson, and Nakanishi 2004). While program costs are relatively easy to measure, quantifying the benefits of goods that are not traded in markets (and hence do not have a known market "price") is more problematic (Weimer and Vining 2005). In essence, what is required is to know what the public would be willing to pay to obtain the good in the absence of direct evidence about actual payments. In the case of an investment in ISFs for consolidating UNF in comparison with more secure on-site storage, the non-market attributes become an important part of the value being considered.

CV surveys have been in use in the U.S. since the 1950s (Mitchell and Carson 1989). The methodology has been the focus of substantial research and validation by federal agencies (including the Environmental Protection Agency and the National Science Foundation), and has been widely employed in federal benefit/cost analyses of environmental resources and environmental policies. In part because the methodology played an important role in the controversial case of the Exxon-Valdez oil spill, the CV method has evolved over the past three decades. A seminal contribution was made when the National Oceanographic and Atmospheric Administration (NOAA) commissioned a study, headed by Nobel-prize winning economists Kenneth Arrow and Robert Solow, to evaluate the applicability of CV methods in federal damage assessments and policy analysis (NOAA 1993).

CV is widely regarded as a useful and important method for providing information about public valuations of benefits that cannot be readily measured in other ways. The advantages of contingent valuations are that they can be designed to directly measure the good in question; this can be presented in the form of a clear trade-off to other expenditures of value to the individual; and the choice can be designed to mirror the kind of market-like purchases that are familiar to most people. Moreover, there are few ready alternatives for measuring public valuations of investments in consolidating UNF. For these reasons, we use CV to provide an indicator of the EE14 respondents' willingness to invest public funds in either ISFs or continued reliance on on-site storage.

The EE14 survey included a set of CV questions that gauge respondents' support and willingness to pay for different storage options. The questions walked respondents through a hypothetical referendum scenario that asked them to vote on one of two storage options—continued on-site storage of UNF or constructing an ISF. The goal was to determine not only which option they prefer, but whether and how much they would be willing to pay for that preferred option. To accomplish this, respondents were provided the following background information about what the two options entail, why they are costly to construct and/or maintain, and why the government would like their input:

Government officials are deciding how to proceed on storing used nuclear fuel in the U.S.

- Their decision on how these materials should be stored could cost you money. For example:
  - Continuing to store used nuclear fuel at nuclear power plants would require heightened security measures and expanding current practices, which is expensive and could mean higher taxes.



- Construction of interim storage facilities and transportation of used nuclear fuel to the facilities is expensive and could mean higher taxes.

Government officials will consider many factors when deciding how to store used nuclear fuel. One factor is whether various options are personally worthwhile to people like you. In the next question, we will describe the effects of two specific options being considered for storage of used nuclear fuel. We would like you to tell us which of these two options you would prefer.

People might consider several factors when deciding which option they prefer, including the cost of each option and the expected effects of each option.

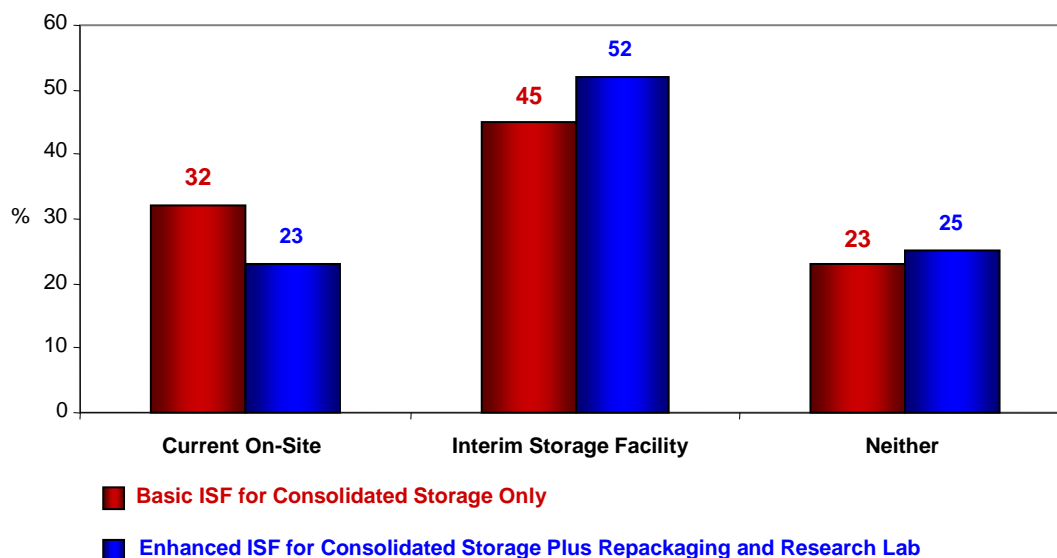
The respondents were then presented two different options—one describing the current practice of on-site storage and the other describing the construction of an ISF. Additionally, as noted above, the EE14 survey employed a split design where half of the respondents received information about a “base” ISF and the other half received information about an “enhanced” ISF with repackaging facilities and a research lab. Below is an example of the options table. The shaded portion was only presented to the respondents who were randomly assigned to receive the “enhanced” ISF option (the order in which the options were presented was also randomized to avoid ordering bias):

Option 1	Option 2
<b>Used nuclear fuel would continue to be stored “on-site” at nuclear power plants.</b> As a reminder:	<b>Used nuclear fuel would be transported to and stored at an interim storage facility.</b> As a reminder:
“On-site” storage is less expensive in the near-term than building an interim storage facility.	Building an interim storage facility is more expensive in the near-term than continuing “on-site” storage.
“On-site” storage is more expensive in the long-term than building an interim storage facility because safety measures must be updated to keep the used nuclear fuel secure at over 100 sites scattered across the country.	Building an interim storage facility is less expensive in the long-term than continuing “on-site” storage because the used nuclear fuel would be stored in a centralized location with state-of-the-art security measures.
“On-site” storage is more vulnerable to risks such as flooding and terrorist attacks than an interim storage facility would be.	An Interim storage facility would be less vulnerable to risks such as flooding and terrorist attacks than “on-site” storage.
“On-site” storage is less vulnerable to risks associated with transporting used nuclear fuel by barge, train, or truck than an “off-site” interim storage facility would be.	An “off-site” interim storage facility is more vulnerable to risks associated with transporting used nuclear fuel by barge, train, or truck than “on-site” storage.
“On-site” storage facilities are not designed to repackage used nuclear fuel for long-term storage and disposal in a permanent repository.	An interim storage facility could be designed to repackage used nuclear fuel for long-term storage and disposal in a permanent repository.
“On-site” storage facilities do not include capabilities to study the characteristics of used nuclear fuel over time, options for storage and permanent disposition, and alternative methods for managing high-level, long-lived radioactive materials.	An interim storage facility could include a research laboratory to study the characteristics of used nuclear fuel over time, options for storage and permanent disposition, and alternative methods for managing high-level, long-lived radioactive materials.
Option 1	Option 2

After viewing this table, respondents were presented with the following question:

Think about a situation in which you had an opportunity to vote for Option 1 or Option 2. Keeping in mind all of the potential effects described for each option above, and if adoption of either option would not cost you anything, would you vote for Option 1 or Option 2?

The results for this question, for both experimental tracks (comparison of continued on-site storage versus (a) the base ISF or (b) the enhanced ISF including a repackaging facility and research lab), are presented in Figure 4.5 below. As the figure shows, in both cases, about one in four of our respondents said that they would not vote for either option. In the base case (shown in red), 32% of the respondents voted to continue on-site storage and 45% voted for the base ISF option. In the enhanced case (shown in blue), 23% of respondents voted to continue on-site storage and a majority (52%) voted for the enhanced ISF option. In other words, the enhancement increased support for the ISF by 7% and decreased support for on-site storage by 9%.



**Figure 4.5: Preferred Options for Interim Storage Facility vs. On-Site Storage**

After the EE14 respondents identified their preferred option for the management of UNF, they were asked if they would still vote for that option if additional taxes were required to pay for it. The size of the tax increase was varied, with respondents randomly presented with increased taxes ranging from \$12 to \$1,200. The question wording was as follows:

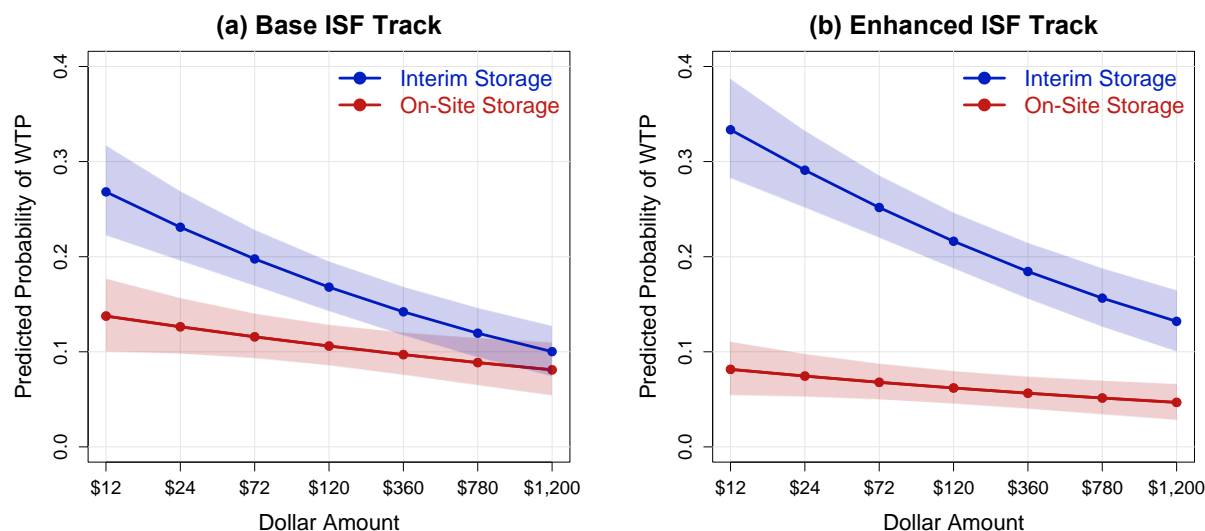
The option you chose will be more expensive to operate [in the long-term/in the near-term]<sup>12</sup>, and will increase the cost to taxpayers. The tax would be added to your electricity bill. As a taxpayer, would you vote for this option? *As you think about your answer, please remember that if this proposal passes, you would have less money for household expenses, charities, groceries, or car payments.*

Would you vote for this option if adoption of this option would cost your household \$[insert randomly assigned dollar amount] in increased taxes every year for the foreseeable future?

- 1 - Definitely no
- 2 - Probably no
- 3 - Not sure
- 4 - Probably yes
- 5 - Definitely yes

<sup>12</sup> Those who said they preferred the on-site storage option saw “long-term”, while those who preferred the interim storage option saw “near-term”.

Figure 4.6 uses the sample data to estimate, for the population, the proportion of the population that would vote for each option at the range of hypothetical tax increases.<sup>13</sup> The shaded band provides the 95% confidence interval for the estimated mean proportion that is willing to pay for an ISF or continued on-site storage at each price interval. Shown in this way, it is evident that (a) WTP declines as the stipulated cost rises; (2) the proportion that is willing to pay for an ISF always exceeds that for on-site storage; and (c) the enhanced ISF is preferred over on-site storage by a substantially larger margin than is the base ISF.



**Figure 4.6: Predicted Willingness to Pay for On-Site Storage vs. ISF**

This analysis demonstrates that EE14 respondents were, on average, more supportive of interim storage than continued on-site storage. The enhanced ISF was preferred over on-site storage by a larger margin than is the base ISF. The analysis also indicates that, on average, a sizable fraction of U.S. residents hold a positive non-market value for constructing an ISF.

### 4.3 Nuclear Accidents and Support for ISF: The Case of WIPP

In tandem with studying the effects of the Fukushima accident on nuclear attitudes, the EE14 survey also asked respondents how the incident at the WIPP facility in New Mexico, U.S. on February 14, 2014 affected their support for a prospective ISF. As was illustrated with the data on the Fukushima event, focusing events involving nuclear accidents have the potential to influence the context within which the public views the risks and benefits associated with nuclear energy. At the same time, incidents like the one at WIPP that involve nuclear storage might have a unique influence on public preferences for siting nuclear storage facilities. WIPP is the only operating deep geologic waste repository in the U.S., and well-publicized incidents that undermine public beliefs that the operators the facility can manage it safely might influence future support for WIPP and other storage facilities.

<sup>13</sup> This parametric display was created using a logistic regression model where willingness to pay was predicted as a function of the dollar amount to which respondents were assigned. The shaded regions represent 95% confidence intervals.

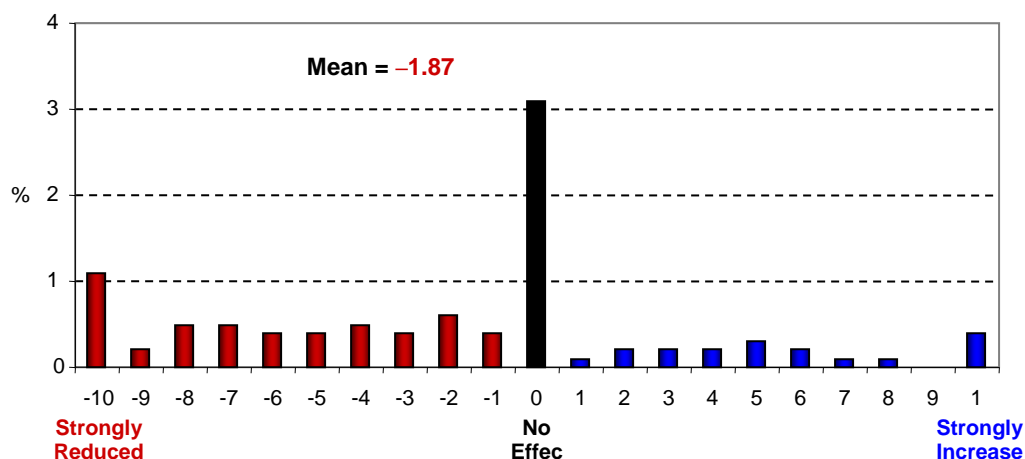
Before asking respondents how the incident at WIPP influenced their support for building ISFs, we asked if they had ever heard about the facility. Only 8% of our respondents said they had previously heard about WIPP. We then described the facility, and the February 2014 incident as follows:

The Waste Isolation Pilot Plant (WIPP) in New Mexico is the only deep geological repository in the U.S. for permanent disposal of certain classes of nuclear waste termed “transuranic materials.” These radioactive materials were created during the production of U.S. nuclear weapons and are being buried in salt deposits at depths of about 2,000 feet under the New Mexico desert. The materials stored at WIPP **DO NOT** include used nuclear fuel from nuclear power plants. The site has been operational since 1999.

On the evening of February 14, 2014, trace amounts of airborne radioactive materials were discovered above ground near the facility. It was determined that 21 workers were exposed to trace levels of radiation. No deaths or serious injuries have been reported, and no one is known to have been exposed to harmful levels of radiation. Pictures from the underground facility show the lid of a drum of waste burst open in a room that is partially filled with containers of radioactive waste. An open drum could release radioactive material into the air flowing through the repository. The cause of the burst lid in an unsealed room is still under investigation at this time.

With this background information in mind, survey respondents were then asked:

On a scale from minus ten to plus ten, where minus ten means the recent experience at the Waste Isolation Pilot Plant (WIPP) in New Mexico *strongly reduces* your support, zero means the WIPP experience has *no effect* on your support, and ten means the WIPP experience *strongly increases* your support, how does the recent release of radiation at WIPP affect your support for building regional interim storage facilities to consolidate used nuclear fuel from more than 100 widely distributed sites in 39 states across the U.S.?



**Figure 4.7: Implications of WIPP Incident for Support of Interim Storage Facility**

As figure 4.7 shows, on the scale ranging from +10 to -10, the mean level of support for building regional ISFs declined by 1.87 points as a result of the WIPP incident. Thirty-one percent of the respondents said that the incident had no effect on their level of support. A near-majority of the respondents (49%) said that their support declined to some extent (values ranging from -1 to -10) because of the WIPP incident. In comparison, only 17% of the respondents said that their support increased to some extent (values ranging from +1 to +10) after the WIPP incident. The persistence of these views will have to be measured in future surveys, but it seems evident that on average, hearing about the WIPP event is likely to have a negative impact on the public’s support for future ISFs.

In sum, this section has provided an overview of public perceptions concerning the management of UNF, the existence of non-market values for ISF options, and likely public responses to the February 2014

WIPP event. First, we found that respondents generally preferred interim storage to on-site storage, especially when they live relatively close to a temporary UNF storage facility. This finding was further corroborated by the results of the CV experiment, which indicated that respondents were more likely to prefer construction of ISFs to continued reliance on on-site storage even at the cost of increased taxes. Finally, we saw in this section that, when apprised of the WIPP incident, respondents indicated that the incident reduced their support for the construction of regional ISFs.

## 5. PUBLIC PERSPECTIVES ON THE INSTITUTIONAL BASIS FOR UNF MANAGEMENT

The BRC was particularly attentive to the importance of institutional credibility and trust because of its potential impact on both the process and outcomes of a nuclear facility siting program. In addition to designing a flexible siting process where key concepts like consent and veto are not predefined, understanding the role of open communication and institutional credibility is crucial. This section presents insights into how people view existing institutions/groups involved in the siting process. We focus as well on how variations in the institutional basis for a new independent agency specifically created for leading the siting process will affect public trust.

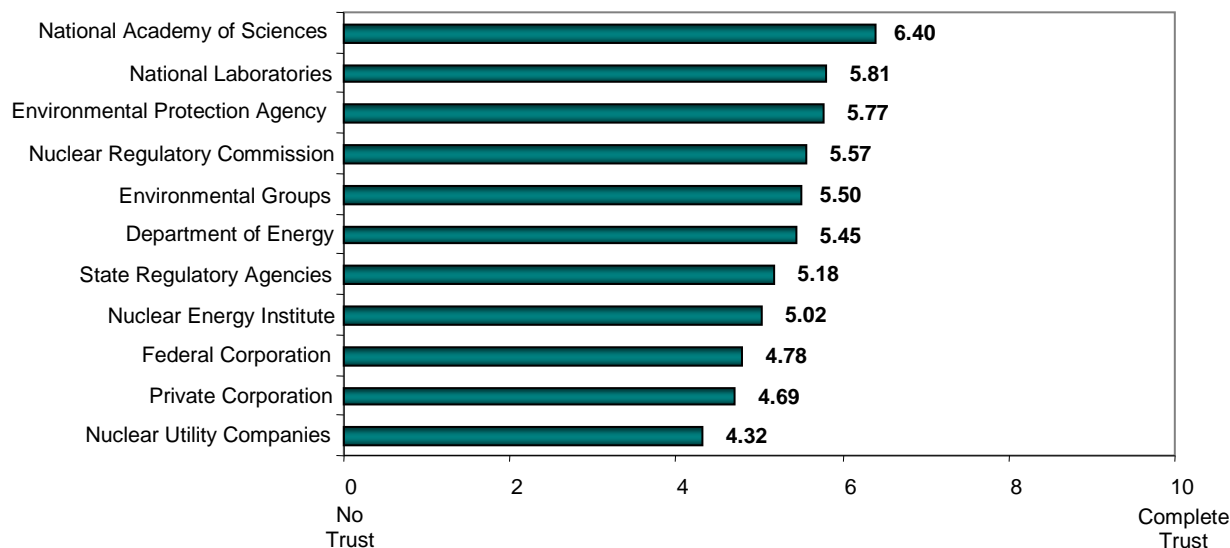
### 5.1 Institutional Trust and Bias

A successful consent-based siting program will require open and transparent communication of benefits and risks. The process is complicated because, when policy choices involve specialized expertise and complex decision making processes, members of the public typically must rely on the expertise of others in deciding whether to support or oppose specific policy options. Nuclear materials management policies, in particular, require the public to rely on information provided by technical experts from a variety of public agencies and groups. To evaluate relative levels of public trust in technical information about UNF management and the valence of public expectations about associated risk assessments, we pursue two related inquiries, beginning with the following questions.

*Lead-in:* Managing used nuclear fuel and other radioactive materials can be technically complex, and getting information you can trust is important. Please indicate your level of trust in information provided by the science and engineering experts from each of the following organizations using a scale from zero to ten, where zero means *no trust* and ten means *complete trust*. (random order)

- The U.S. Nuclear Regulatory Commission
- The U.S. Environmental Protection Agency
- U.S. national laboratories for energy and security
- The National Academy of Sciences
- State regulatory agencies
- Environmental advocacy groups, such as the National Resources Defense Council or the Sierra Club
- The Nuclear Energy Institute, which represents the nuclear power industry
- Utility companies that own nuclear power plants
- The U.S. Department of Energy
- A *private* corporation that is partially funded by fees from nuclear energy, and that would be responsible for managing used nuclear fuel from U.S. nuclear power plants. (See further discussion of this item in Section 5.2, below)
- A *federal* corporation chartered by Congress and partially funded by fees from nuclear energy that would be responsible for managing used nuclear fuel from U.S. nuclear power plants. (See further discussion of this item in Section 5.2, below)

The mean responses, ordered from highest to lowest trust in the scientific and technical information provided by experts from each group, are shown in Figure 5.1.



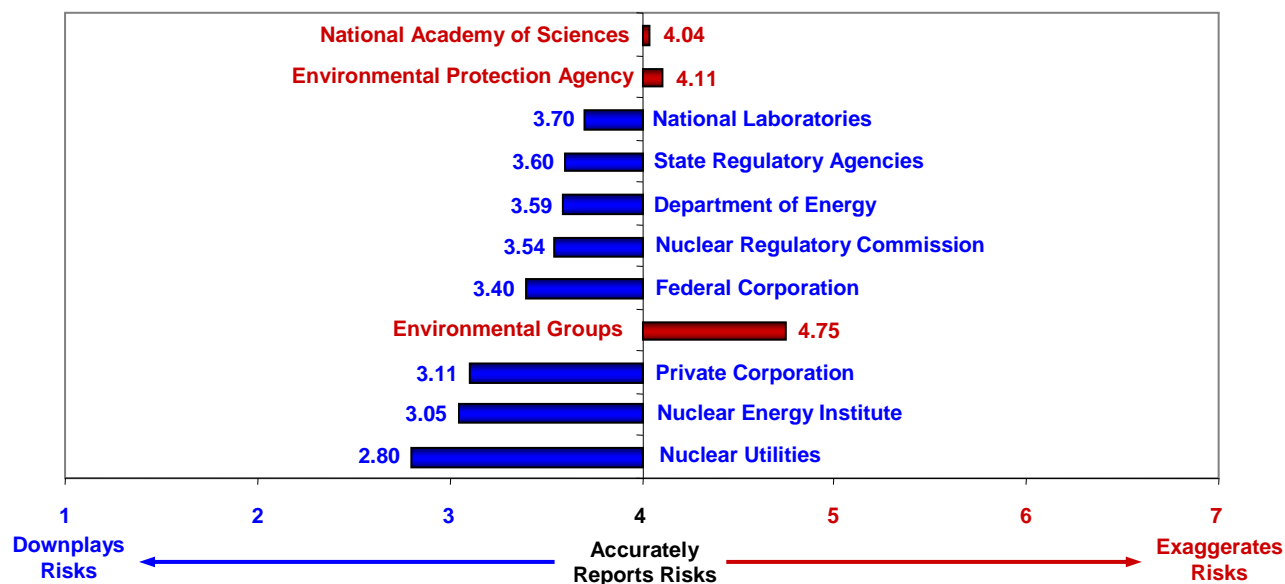
**Figure 5.1: Mean Institutional Trust in Information about Used nuclear fuel**

Average levels of trust in information sources vary significantly, with greatest trust accorded to technical experts from the National Academy of Sciences. Experts from the national laboratories are rated second, with experts from federal regulatory agencies (EPA and NRC) very close behind. Technical experts from environmental advocacy groups and the U.S. DOE are rated next in average levels of trust. State regulators fall slightly lower on the list. Note that experts from all of these organizations score significantly above the scale mid-point for public trust. Mean trust scores for technical experts from the Nuclear Energy Institute and nuclear utilities fall significantly below those for the federal agencies and environmental groups. Of significance is the relatively low trust accorded either a federally chartered or industry-backed entity charged with siting facilities for nuclear storage or disposal. This finding is discussed in greater detail below in Section 5.2.

Next we focus on the *valence* of the expected bias by experts in each of the groups listed above. Because trust is not perfect for any of the groups studied, it is important to understand whether members of the public perceive a systematic pattern of bias from experts within the array of organizations and groups involved in UNF facility siting debates. Our interest is in understanding whether some groups are perceived to systematically understate or downplay risks associated with nuclear materials management, while others may be perceived to exaggerate those risks. To address this issue, we ask the following question:

Now we want to know more about impressions you may have about how these organizations are likely to assess risks associated with managing used nuclear fuel. Using a scale from one to seven, where one means the organization is likely to downplay risks, four means the organization is likely to accurately assess risks, and seven means the organization is likely to exaggerate risks, please rate your impressions of how each organization is likely to assess risks.

The mean values for the perceived bias in scientific and technical information provided by technical experts representing each of the groups is shown in Figure 5.2.



**Figure 5.2: Mean Levels of Perceived Bias in Institutional Risk Assessments**

In general, the results in Figure 5.2 show that the National Academy is viewed as providing balanced scientific and technical information bearing on the risks of managing UNF. The EPA is perceived to have a slight bias toward exaggerating such risks, while the U.S. national laboratories, state regulators, the DOE and regulatory agencies continue to be viewed as reasonably credible, though with a modest propensity to downplay risks. Both industry groups and environmental NGOs are broadly perceived to be more prone to skew the representation of risks (though in opposite directions). Note that both the federally chartered and industry-backed corporations tasked with nuclear facility siting are expected to downplay risks, though the privately-backed version is expected to be significantly more biased. These perceptions of bias serve to filter the scientific and technical information and policy recommendations concerning nuclear waste options received by a public that is less than well informed about the particulars of the nuclear waste cycle (as shown in Section 2).

## 5.2 Public Perspectives on a New Managing Organization for UNF: “Fedcorp”

In addition to highlighting the importance of trust and credibility during the siting process, the BRC report also noted an apparent lack of public trust in the DOE. To build trust and garner success during the siting process, the BRC recommended the creation of a new organization “to provide the stability, focus, and credibility that are essential to get the waste program back on track” (BRC, 2012, p. x). It was proposed that this new organization be defined as a private company chartered by the government and funded by fees from nuclear energy.<sup>14</sup> The goal was to designate a new organization to wield nuclear waste management authority, one that could elicit greater trust from the public and enhance the legitimacy of UNF management processes. Results from the 2012 EE survey suggested that gaining public trust for a waste management authority modeled on the BRC’s recommendation may be more difficult than expected (Jenkins-Smith et. al. 2012, p. 34). Possible reasons for the low level of expressed trust in the

<sup>14</sup> The BRC recommended the formation of a new single-purpose, government-chartered, private company outside DOE to oversee UNF policy management; we call this organization “Fedcorp” for ease of reference.



BRC's model include the nascent nature of the concept and its characterization as a private company chartered by the federal government. In short, the *institutional design* of the entity may be influencing the initial levels of trust from the public.

To analyze the relationship between trust and the institutional characterization of the nuclear waste authority, the EE14 survey conducted a split design experiment in which the definition of the Fedcorp entity was varied. The descriptions for the two different institutional designed for the Fedcorp entity were as follows:

1. A private corporation that is partially funded by fees from nuclear energy, and that would be responsible for managing used nuclear fuel from U.S. nuclear power plants. It would be governed by a Board of Directors made up of experts from the nuclear industry, and it would be subject to federal safety regulations.
2. A federal corporation chartered by Congress and partially funded by fees from nuclear energy that would be responsible for managing used nuclear fuel from U.S. nuclear power plants. It would be governed by a Board of Directors made up of experts from the government, industry and universities, and it would be subject to federal safety regulations and Congressional oversight.

Each respondent was randomly assigned to consider one of these two institutional Fedcorp designs.

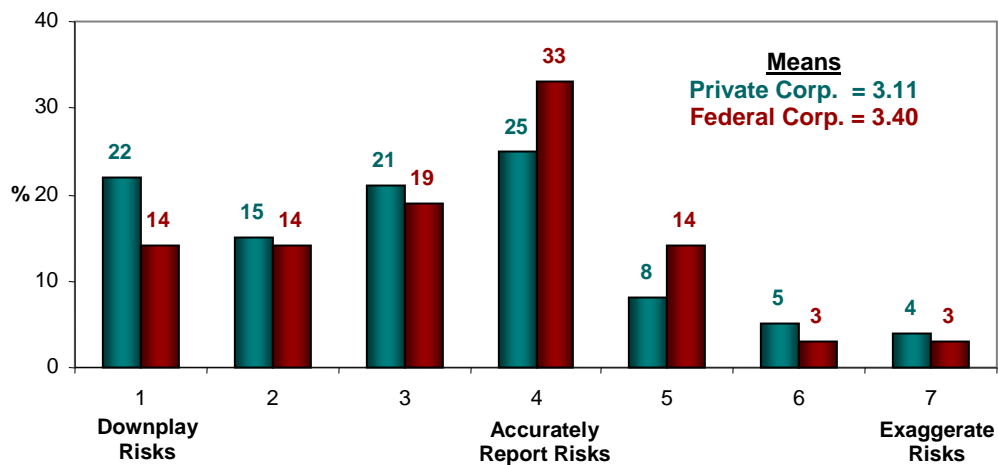
In the first step of the experiment, respondents were asked to rate their level of trust for the described organization, along with the other actors as discussed previously in Section 5.1. The results are shown above in Figure 5.1. Note that the average level of trust for the provision of trusted scientific and technical information about the risks of nuclear materials management by either of the two Fedcorp designs fell well down the list of actors, above only that for the nuclear utilities. Trust for the federal version of the Fedcorp was higher than that for the private one, but only marginally (4.78 versus 4.69).

In the second step of the experiment, respondents were asked to indicate the expected direction and extent of "bias" they thought the Fedcorp entity – in comparison with other key institutional stakeholders in fuel cycle management policy – would display in its assessment of the risks posed by management of UNF. Recall that the question was framed as follows:

Using a scale from one to seven, where one means the organization is likely to *downplay* risks, four means the organization is likely to *accurately assess* risks, and seven means the organization is likely to *exaggerate* risks, please rate your impressions of how each organization is likely to assess risks.

The distribution of the responses to the two randomly assigned characterizations of Fedcorp, in comparison with the other organizations, are shown above in Figure 5.2. Recall that technical experts form both versions of the Fedcorp were expected downplay risks. However, the federal version of Fedcorp was expected to exhibit significantly less bias than the private version.

The full distributions of responses to the perceived risk bias question are shown below in Figure 5.3. As is evident in the figure, a majority of survey respondents expected the private Fedcorp entity to downplay risks of nuclear materials management (58%). In comparison, slightly less (47%) expected the federally chartered version of the Fedcorp to downplay those risks.



**Figure 5.3: Distribution of Federal vs. Private "Fedcorp" Perceived Risk Bias**

Overall, the results described in this section indicate that respondents expected that a federally chartered organization would be more trustworthy, and less biased, than a private organization. Note, however, that these observations concern *a priori* perceptions about bias and trust, based only on the description of the institutional structure of the new nuclear waste authority. Garnering public trust will require more than just the formal institution of a new organization. The new authority will need to persuade the public and stakeholders that it provides balanced information and unbiased risk assessments.

## 6. PUBLIC PERSPECTIVES ON THE DESIGN OF A CONSENT-BASED SITING PROCESS

When thinking about a consent-based siting process, some of the key elements include flexibility, adaptability, and collaboration with the public in characterizing the facility siting process. The BRC's final report provided a broad outline for such a process, including:

- Develop a set of basic initial siting criteria;
- Encourage expressions of interest from a large variety of communities that have potentially suitable sites; and
- Establish initial program milestones.

In line with the BRC recommendations, the U.S. DOE described a consent-based facilities siting process to include:

- Agreement at multiple jurisdictional levels
- Open and transparent communication of benefits and risks
- Mutually agreed upon off-ramps

Public perceptions about accurate communication of risks and benefits were discussed in the previous section. This section expands on the other two bullet points listed above, which relate to inclusiveness of the consent process, veto authority, and withdrawing consent. The EE14 survey was designed to provide data on broad public preferences regarding (a) how open and inclusive the process of soliciting consent should be; (b) what kinds of stakeholders should hold critical “veto” authority within that process; and (c) at what point in the siting process consent becomes irrevocable by the host community. Each of these points is addressed below.

### 6.1 Inclusiveness of Consent Process

The BRC recommendations, the U.S. DOE's strategy as briefly described above, and experiences from international cases all indicate that an inclusive nuclear facility siting program focused on stakeholder engagement is more likely to succeed than a “top-down” program in which an agency seeks to convince a community to host a facility based primarily on technical criteria. What remains undefined, however, is how inclusive and open such a program might be.

The EE14 survey respondents were asked a series of questions concerning their preferences for defining consent in the context of UNF facility siting. Respondents were provided with the following prelude, and two different definitions of consent. They were then asked which definition of consent they were more likely to support. The question wording was as follows:

Assume that a small rural community located about 50 miles from your primary residence in [insert state] has volunteered to host an interim storage facility for used nuclear fuel. Which of the following definitions of consent would you most support?

“Consent” should involve a process where many different stakeholders must agree. Thus consent should require agreement by local elected officials, [insert state]’s governor, both of [insert state]’s U.S. senators, the U.S. congressperson representing the host community, and [insert state]’s environmental protection agencies. In addition, consent should require that, in a state-wide vote, a majority of citizens in [insert state] support siting the interim storage facility. [Hereafter referred to as the *more inclusive* definition of consent]

“Consent” should involve a process where only the elected representatives of those that are most affected must agree. Thus consent should require agreement by local elected officials and [insert state]’s governor. [Hereafter referred to as the *less inclusive* definition of consent]

Table 6.1 presents the distribution of responses to the question, and shows how preferences for defining consent are related to the support for an ISF, ideological beliefs, and gender of the survey respondents.

**Table 6.1: Public Responses to What Constitutes Consent**

%	ALL	Oppose ISF	Support ISF	Liberal	Conserv.	Women	Men
More inclusive process	<b>84%</b>	85%	81%	87%	80%	86%	81%
Less inclusive process	<b>16%</b>	15%	19%	13%	20%	14%	19%

When asked whether they support a more or less inclusive process of consent, an overwhelming majority of the respondents (84%) chose the more inclusive definition. Also as shown in Table 6.1, the preference for the more inclusive definition of consent is consistent across subgroups of the sample. Both those who support and oppose the siting of an ISF prefer the more inclusive definition by large majorities, as do both liberals and conservatives, and men and women. A similar pattern is evident across respondents from different regions of the U.S. In short, among all subgroups in our sample, about four out of five respondents believe that consent for siting a nuclear storage facility will require engaging a range of representatives, organizations and subpopulations in the affected region.

## 6.2 Consent and Veto Authority

While a majority of the EE14 respondents prefer a more inclusive process for siting a UNF facility, preferences for which groups have a more decisive role are less uniform. Inclusion in the engagement process needs to imply that all participants play equal roles. In order to understand which stakeholders the public would consider as having a more central role – the capacity to formally block or veto the selection of a site – survey participants were first asked to assume that “a small community that is about 50 miles from your primary residence ... has volunteered to be considered for hosting an interim storage facility for used nuclear fuel.” They were then presented with a randomly ordered list of stakeholders (as shown in Table 6.2) and asked:

Please select all those on the following list that you think should be allowed to block or veto the construction of a proposed interim storage facility for used nuclear fuel in [insert state]:

**Table 6.2: Who Should Have Authority to Block/Veto a Siting Decision?**

<i>Who should be allowed to block / veto a siting decision for an ISF?</i>	<i>%</i>
A majority of citizens, including those in Native American communities, residing within 50 miles of the facility	<b>66</b>
A majority of voters in the host state, including affected Native American communities	<b>64</b>
Host state environmental protection agency or equivalent	<b>55</b>
Governor of the host state	<b>52</b>
U.S. Environmental Protection Agency	<b>50</b>
U.S. Department of Energy	44
U.S. Nuclear Regulatory Commission	43
Leaders of the host state's legislature	39
U.S. Congressperson representing the host district	39
Either of the two U.S. Senators representing the host state	39
Nongovernmental environmental groups in the host state	26

As shown in Table 6.2, only five categories of stakeholders received majority (or near majority) support for veto authority: (1) the citizens, including those in Native American communities, residing within 50 miles of the facility; (2) the voters, including affected Native American communities, in the state; (3) the host state environmental protection agency or equivalent; (4) the governor of the host state; and (5) the U.S. Environmental Protection Agency. These responses demonstrate that, although respondents supported a broad and inclusive definition of consent, preferences for granting authority to block or veto siting were restricted more narrowly to those residents most directly affected, and to the state and federal environmental protection agencies.

### 6.3 Withdrawing Consent

Finally, the EE14 survey focused on the question of defining what the agreed upon “off-ramps” should be during the consent process. In other words, when, in the course of the siting process, can consent be withdrawn after a community and state had initially opted to consider hosting an ISF? Respondents were provided a description of five “stages” of the siting process, and were then asked whether a host state and local community should be allowed to withdraw consent for ISF siting at each stage in the process. Response options were “no” or “yes.” The introduction and characterization of the five steps of the siting process provided to respondents are shown below:

A related issue involves if and when consent might be withdrawn. The siting process will proceed in stages, and at some point a final decision to build or not to build the facility must be made. Each of these stages requires considerable investment of money and time. Each stage also provides more information for making a good decision. Generally, these stages include:

Step 1: The community or state volunteers to be a candidate to host an interim storage facility for used nuclear fuel, and a technical evaluation of the site is begun. This evaluation may take several years to complete.

Step 2: Technical evaluation of the suitability of the site for interim storage of used nuclear fuel is completed.

Step 3: If the site is determined to be suitable, a license to construct an interim storage facility for used nuclear fuel is submitted to U.S. regulatory agencies; the regulatory consideration may take several years to complete.

Step 4: If the license is provided, construction of an interim storage facility for used nuclear fuel begins. Construction will take several years to complete.

Step 5: Construction is completed, and the interim storage facility is prepared to receive used nuclear fuel.

The percentages of respondents indicating that states and local communities should be able to withdraw consent at each stage of the facility siting process are shown in Table 6.3.

**Table 6.3: Preferences for Allowing Withdrawal of Consent During the ISF Siting Process**

<i>When should host community be allowed to withdraw consent?</i>	<i>% Yes</i>
Host community/state volunteers; site assessment is initiated	<b>79</b>
Scientific evaluation of site suitability is completed	<b>77</b>
Application for a license to construct a UNF facility is submitted to agencies	<b>72</b>
License is obtained; facility construction is initiated	49
Construction is completed; facility is prepared to receive UNF	34

Substantial majorities of respondents thought potential host communities and/or states should be permitted to withdraw consent at each of the first three stages of siting an interim storage facility. After a license has been obtained, however, the percentage of respondents who thought that consent could be withdrawn dropped to below 50%. In the final stage of the siting process, once construction is complete, that percentage dropped still further to about three in ten.

In summary, when asked to reflect on how they would prefer to implement a consent-based siting process, EE14 survey respondents indicated that they would prefer the following:

1. A consent process that is broadly inclusive of the public, representatives and organizations in the affected area and state;
2. A restricted subset of actors – local public, governors and agencies charged with environmental protection – who will play a more decisive role in determining whether the facility can be sited; and
3. Limiting the right of states and localities to withdraw from the siting process to those stages prior to initiation of construction of the facility.

## 7. PROSPECTIVE PUBLIC ENGAGEMENT IN SITING ISF AND UNF TRANSPORT CORRIDORS

Public engagement in the siting process has gained popularity in the last decade, both in principle and in practice. In principle, it is recognized and widely agreed upon that stakeholder engagement is likely to play a significant role in the design and implementation of a successful siting process. The BRC recommended that “legislation to establish a new waste management organization include appropriate mechanisms to facilitate and support constructive stakeholder participation” (BRC 2012, p. 67). Furthermore, as shown in the prior section, a large majority of the EE14 respondents believed that the voters and residents of the host state should have veto authority in the consent process. In practice, examples from Sweden and Finland help corroborate these views. Little is known, however, about what to expect about how members of the public will engage in such a process. For that reason, the EE14 survey included a set of questions focusing on respondents’ expectations about *how* they might engage, the expected *levels* of engagement, and the *types* of deliberation panel they prefer.

### 7.1 Engagement in an ISF Siting Process

Before asking them about the kinds of prospective engagement activities in which they might participate, EE14 respondents were provided the following background information:

Public engagement in the process of developing interim storage sites will be critical. We want to know how likely it is that you would actively participate in the debate and policy process if construction of an interim storage site for used nuclear fuel was proposed within 50 miles of your residence in [insert state]. We understand that you cannot be sure about your precise level of involvement, but please be as realistic as possible when responding to the following questions using a scale from one to seven, where one means *not at all likely*, and seven means *extremely likely*.

Respondents were then provided, in random order, the following list of activities and asked to indicate their expected likelihood of engaging in each:

- Attend informational meetings held by authorities
- Write or phone your elected representatives
- Express your opinion using social media
- Serve on a citizens’ advisory committee
- Help organize public *support*
- Help organize public *opposition*
- Speak at a public hearing in your area

For each response, respondents were coded as “likely” to engage if their response was above the midpoint (5 or higher) on the scale. The results are shown in the Table 7.1.

**Table 7.1: Public Responses to Likely Engagement in the Siting Process**

<b>Likely to ... (% with score above scale mid-point)</b>	<b>2014</b>	<b>2013</b>
Attend informational meetings held by authorities	50%	51%
Write or phone your elected representatives	43%	47%
Express your opinion using social media	44%	43%
Serve on a citizens' advisory committee	37%	37%
Speak at a public hearing in your area	25%	21%
Help organize public <i>support</i>	22%	22%
Help organize public <i>opposition</i>	24%	21%

As indicated in Table 7.1, half of the EE14 respondents said it was more likely than not that they would attend public information meetings on siting an ISF within 50 miles of their homes. The next most likely activities were contacting their elected representatives (43%) and expressing their opinions using social media forums (44%). Somewhat fewer (37%) said they would be willing to serve on a citizen's advisory board to provide advice and oversight for the siting authority. Fewer still (25%) said they would speak at a public meeting on the issue.

The survey also asked respondents about the likelihood that they would help organize public support or opposition in response to a siting effort. Roughly one in five of the EE14 respondents said they would be more likely than not to help organize support for a prospective ISF within 50 miles of their homes. A similar number said they would be likely to help organize opposition to a proposed nearby ISF. For both groups, the chief predictor of the likelihood of engagement was their more general propensity to be involved in local civic issues; higher levels of local activism are correlated with a greater expectation of engagement on the issue of siting an ISF. Older respondents, and those with higher levels of education, said they were *less* likely to participate in opposing the facility (but there is no association between education and support). Men said they were more likely to engage in supporting an ISF than did women (but there is no association between gender and engaging in opposition to a facility). The closer the proximity of the respondent's residence to a current UNF storage site, the greater the likelihood that they would engage in *either* support or opposition to siting the ISF. And, as expected, opposition to a policy of building one or more ISFs is positively associated with the likelihood of engaging in opposition.<sup>15</sup>

## **7.2 Public Preferences for Deliberative Decision-making Panels in ISF Siting Process**

Deliberation is an integral form of citizen engagement and democratic decision-making, and can significantly influence the implementation of a consent-based siting process. Nuclear energy is a complex issue and, given the relatively uninformed public (see Section 3 of this report), informed decision-making will require citizens to engage in discussions about the technical and social concerns involved in facility siting. Deliberative engagement can take many forms. At one end of the spectrum, citizens and a diverse array of stakeholders drive the deliberative process—they can organize, ask questions, and make recommendations. At the other end of the spectrum, experts drive the process—they organize, answer questions raised by citizens and stakeholders, and then make recommendations based

<sup>15</sup> For more information on the predictors of likely engagement, see Troussset, Gupta, Jenkins-Smith, Silva, and Herron (Forthcoming 2015).



on public input. Both options involve some form of citizen and stakeholder engagement. They differ, however, in the amount and decisiveness of the input that citizens and stakeholders provide.

The EE14 survey included a set of questions designed to gauge public preferences about which option for deliberation they preferred—citizen led or expert led panels? Before asking them to express a preference, respondents were provided the following background information:

In the past, policy decisions related to scientific and technical issues like where to build storage facilities for used nuclear fuel have been based on the recommendations of a “technical expert panel.” These expert panels are typically made up of scientists and engineers hired by the federal government. Because expert participants have specialized knowledge about the various technical aspects of a proposed site, utilizing expert panels often ensures that the most up-to-date scientific and technical information is considered in making policy decisions.

Recently, there has been interest in getting local citizens more involved in decision-making regarding technically complex policy problems. One way to get citizens involved is to assemble a citizen panel, made up of 10-20 citizens from the potential host community that would be most affected by the policy decision. Citizen participants would be selected through a process similar to jury selection. Once selected to be on citizen panels, participants first would be given scientific information in order to learn about and discuss the topic in depth. The panel would then meet to discuss the issue in the presence of a moderator to ensure fair and respectful discussion among citizens. Because citizens have knowledge about the community that would be affected, utilizing citizen panels would ensure that the most relevant community concerns are considered in making policy decisions. This process is referred to as a “deliberative citizen panel.”

Key arguments that are made FOR *deliberative citizen panels* include the following:

- Citizen panels help educate citizens and communities by building a strong information base about the policy issue at hand, especially if the issue is highly technical or scientific in nature.
- Citizen panels give members of the local community a chance to hear a wider range of opinions and views on the issue from their fellow citizens, community leaders, and technical or scientific experts.
- Citizen panels give members of the community an opportunity to influence public policy and therefore may result in decisions they are more likely to understand and support.

Key arguments that are made AGAINST *deliberative citizen panels* include the following:

- Citizen panels may result in members of the community influencing public policy about complex technical and scientific issues that they do not fully understand.
- Citizen panels may be uncomfortable or challenging for some citizens who don’t typically engage in political discussions.
- Citizen panels demand a lot of time and effort from the members that agree to be on the panel. Some citizens do not have the time or resources to attend these panels and thus cannot be a part of the process.

Key arguments that are made FOR expert panels include the following:

- Expert panels ensure that the most up-to-date scientific and technical information is considered, leading to the adoption of the best scientific and technical decision.
- Expert panels consist of individuals who have the scientific and technical knowledge to understand the issues at hand and can therefore make recommendations that are of a sound basis.
- Expert panels ensure that different perspectives from various scientific disciplines are brought together to improve current analytical methods and also identify the need for additional information.

Key arguments that are made AGAINST expert panels include the following:

- Expert panels limit the consideration of non-technical aspects of a policy issue, such as ethical and social concerns.

- Expert panels restrict citizen input into decision-making processes, and may result in socially undesirable and contentious decisions.
- Expert panels consist of individuals who may not act objectively or may sometimes disagree about scientific information presented to them.

With this information in mind, EE14 respondents were then provided a hypothetical scenario about siting an ISF facility within 50 miles of their primary residence. About half of the respondents were randomly chosen to receive a decision-making scenario using expert panels. The other half received a decision-making scenario using citizen panels. They were then asked two questions—one about their support for that type of process and the other about their support for the (hypothetical) decision to site the facility in their community if that decision was the result of the stipulated process. The following question wording was used:

On a scale of one to seven, where one means *strongly oppose* and seven means *strongly support*, how do you feel about relying on a(n) [expert panel OR citizen panel] process to make the decision on whether to build an interim storage facility within 50 miles of your home?

Now, assume that a(n) [expert panel OR citizen panel] process has been conducted in your community and the decision has been made to build the storage facility at the proposed site within 50 miles of your home. On a scale of one to seven, where one means *strongly oppose* and seven means *strongly support*, how would you feel about the decision to build the interim storage facility at that location?

**Table 7.2: Mean Level of Support for Decision-making Process and Outcome to Site an ISF**

Mean Level of Support for... (1=Strongly oppose, 7=Strongly support)		
Scenario	Decision-making Process	Decision-making Outcome
<b>Expert Panel</b>	3.82	3.40
<b>Citizen Panel</b>	4.08	3.50

As shown in Table 7.2, respondents that were assigned to the citizen panel scenario were more likely to support the decision-making process than were respondents assigned to the expert panel scenario. On average, the level of support for using a citizen panel as a process to make decisions about siting an ISF was slightly above midscale (4.08). Forty percent of the respondents said they would support the citizen-led process, while 32% were neutral and 28% were opposed. In comparison, the mean level of support for using an expert panel as a process to make decisions about an ISF was below midscale (3.82); only 34% supported the expert-led process, while 27% were neutral and 38 percent were opposed. This difference was statistically significant, indicating that residents generally are more likely to support a citizen panel process than an expert panel process. However, when asked about how likely they would be to support the outcome from these deliberative panels if the resulting recommendation was to site the facility, the responses were very similar across the scenarios: pluralities of the respondents (49% for the expert-led process, and 43% of the citizen-led process) opposed the siting of the ISF *regardless* of the process used.

These results indicate that, in the early stages of considering processes for consent-based siting, opting for a deliberative citizen-led approach is likely to garner greater public support than is an expert-led approach. At the same time, our findings suggest that the anticipated effect of the method of engagement on support for the hypothetical outcome of the process is neither large nor statistically significant. This is to be expected; the survey respondents did not benefit from either observing or participating in such a process. Experience with actual siting processes (without the kinds of citizen-led deliberative processes

considered here) suggests that, absent determined opposition by the affected states and localities, public support can grow over time as the process unfolds.<sup>16</sup> Thus, fielding a siting process that includes citizen-led deliberative processes may lead to greater support for that process which, once it has run its course, might increase citizen support for the siting outcome.

In sum, this section has asked and answered questions concerning respondents' expectations about their engagement in the ISF facility process. Roughly half of EE14 respondents say they would be likely to attend informational meetings, and nearly half say they would be likely to communicate with elected officials or to express their views on the topic via social media. Relatively few – about one in five – say they would be likely to actively participate in support for or opposition of an ISF. Also, in reference to the type of deliberative panels the respondents prefer, results indicate that while respondents are more likely to support a citizen-led deliberative panel process than one led by experts, this preference does not seem to influence their opinion about the expected outcome of that process. This suggests that decisions about how to structure engagement are important—people prefer citizen driven processes, but preferences for a deliberative process do not predispose members of the public to support the construction of an ISF even if that is the recommendation of the process.

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<sup>16</sup> Jenkins-Smith et al 2011. Note that estimating the effect of a citizen-led deliberative process on support for the outcomes of that process would require fielding a study that engages a sample of citizens to participate in a deliberative forum about ISF siting issues. A survey of the kind described in this report cannot adequately simulate the effects of deliberative engagement.

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